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CONTENTS.

Chief Ikaneng (1886–1896).

Chief Mokgosi II. (1896–1906).

Acting Chief Baitlutle (1906–1917).

Chief Seboko Mokgosi (1917–1937).

Neill & Co., Ltd.

"DI RŌBARŌBA MATLHAKOLA—TSA GA MASODI-A-MPHELA."

History of the Ba-Ga-Malete of Ramoutsa (Bechuanaland Protectorate).

By Vivien Ellenberger,
District Commissioner, Bechuanaland Protectorate,

With the assistance of Chief Seboko, Headman Lokote Motladiile, other members of the tribe, and Mr. Levi Moumakoa, Principal of the Bamalete National School.

(Communicated by A. J. H. Goodwin.)

(Read April 15, 1936. Revised MS. received November 30, 1936.)

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This History of the Ba-ga-Malete has been prepared primarily for the People to whom it refers, and is intended to be as much a gesture of good-will—to cement the ties of friendship and understanding between a District Officer and his people—as the expression of a desire to give practical effect to the wishes of the African People that the histories of their Tribes be recorded ere it is too late.

The author desires to acknowledge in full measure his sense of deep gratitude to Professor I. Schapera, of the School of African Studies, University of Cape Town, for his advice, instruction, and encouragement, for revising the MS. and correcting the proofs; and to express his thanks to Mr. H. J. E. Dumbrell, O.B.E., Director of Education, Bechuanaland Protectorate, for suggestions and other valuable assistance; to Miss M. Gill for making the drawing of the tribal emblem reproduced overleaf; and to his wife for the help which only a wife can give.

AUTHOR'S NOTE.

The author records with the utmost regret the death of Chief Seboko Mokgosi on the 11th of July 1937. On the 17th July 1937 his minor son Mokgosi was formally recognised by the Tribe as the heir to the chieftainship, and his uncle, Ketswerebothata, was appointed to act as Chief.

Part I.—PRAISES OF THE CHIEFS (with TRANSLATIONS).

Praises of the Chief Mokgōywe-a-Pooè.

Kgomo e dinaka dikgolo, Mokgōywe,
E tlhaba ka tsōnè, ga di imèlè.
Mokgōywe-a-Pooè o gama marumō
Dikgomo ke tsōnè o sa di gameng;
Dikgomo o gama tsoo Rra-Mathwanyana,
O gama tsoo Mongala-a-Mathwanyana.
Moteketwa oa bo Mma-Motswasele,
O Senyeri le Pulane.
Phatudi rumō la maara sebete,
Rumō la tlhaba la fetètsa lotswalō.

Mokgōywe, ox with the big horns, who pokes with them for they do not encumber him.
Mokgōywe-a-Pooè who plucks his foe's spear to stab him, who milks not cattle—servants do that;
The cattle he does milk are those of Mathwanyana's father, and those of Mongala, the son of Mathwanyana.[1]
Mokgōywe, the butt of all and sundry,
O Senyeri[2] and Pulane.[3]
His spear went through Phatudi's liver and heart-sac.

[1] ? Makaba I of the BaNgwaketsi.
[2] Mokgōywe's sister.
[3] Mokgōywe's mother.

Praises of Phōkō-a-Boiyane.

(After repulsing a BaKgatla raid on Ba-ga-Malete cattle, which he re-captured single-handed.)

I. Kgomo ea ngopè la ga Soko, khunwana,
E ntsaea ka mosepele,
Ke sale ke tsoga ke e latètse,
Ea tshoga ka tsatsi le wèla.

II. Meupelele eo meupōupō o upilwe ke rragwè Sebogodi,
A upwa ke Mokgatlha-a-Tshwene,
A re "tsamaea, u e go nna kwa Motlhatseng, u upilwe,

Ga nka u tswarwa ke sepe, u railwe."
Le ga Pooè a gu upetse Motlhatsa,
Thèmè ea lebōtō la ga Motlabatlaba,
Thèmè ga lo tlhabè lo mo gakaditse,
Lo mo tsènètse kwa o lalang,
Lo tsene kwa Thèmè o robala teng,
E be e nene Thèmè a tloga a lo bolaea,
Thèmè a tloga a lo gatisa mmitlwa.
Lerumō la thipa mogatsa Kgongwana-a-Mosètlha
La ga mogatsa se lohilwe sefhafha;
A go ko u nnaea lengwe ka gu bōka?
La boraro ga se lerumo tshwaana,
Tshwaana e batisa batho merotō:
Ka erile lo fheta Dibasechobe gwa galaotèga tlou,
Ea tswa fha Tshwene-tshwene:
Ka erile e kwetoga Tlhaba-batho
Ea tlhaga ka naka dile dikhubidu
Ka naka dile merodi ea ntwa,
Di hubiditswe ke madi a BaKgatla-ba-ga-Kgafèla.
Lopetleke lwa ga morwa Boiyane!
O petlekilwe motho yaka tau,
Ka mo gōga, ka mo katosa sefhifi
Kare ba gagabō ba seka ba seraia
Ba raia metlhala ea ga Ntshonyana.
Kgomo e tswana ea ga Kgopu-ea-ga-Tshwene
E tswana ea ga Kgopu-ea-ga-Moatlhodi,
Ga e tlhole e senkèlwa mmudulō,
Se ètèla thamaga pele, e dinaka ea Masweu.
Ramosilong, ōmanya mogoloo:
Ke mo ōmanye, ke mo rèè ke reng?
A ke tla ōmanya motho a le bogale?
Eare go tshabya a sala a eme,
A salè a setlaka mo mabutung mo ga Motlabatlaba.
Kgomo e longwa ke lothōywè, Tsetlaki,
Kwa ga Malete-a-Badimo.
Ke konopye ke bo Motlotle oa ga Kgafèla,
Ba nkonopa ka marumō a a metlantlanyana.
A le wena Motlotle, a u monna?
A u ithuta ka nna go konopa?

I. The cow of Soko's spruit is red and takes me on a long journey:
I have followed it since sunrise and it leaps away again as the sun sets.

II. The doctored son who has been properly doctored by the father of Sebogodi,[1]

The son who was doctored by Mokgatlha-a-Tshwene,[2] who said to him, "Go and stay at the Motlhatsa tree, you have been properly doctored and no harm will befall you."

Even though Pooè has willed you [3] to remain at the Motlhatsa tree, the rhinoceros of the foot-hills of Motlabatlaba [4] does not charge because you [5] have made it angry but because you have been into the place where it sleeps;

You have penetrated into its resting-place, that is the reason why it took to killing you, why it drove you through the bush and you trod on thorns.

The spear (the one used also as a knife) of your husband Phoko is bound with feathers, Kgongwana-a-Mosètlha—will you not give me one that I may praise you?

The third will not be an ordinary spear but a short stabbing spear, the short stabbing spear that makes men urinate;

For, when you passed Vleischfontein, an elephant trumpeted; [6] it came from the direction of Tshwene-tshwene, and when it appeared from behind Tlhaba-batho hill it emerged with tusks all red as if with the stains of fighting—reddened by the blood of Kgafela's BaKgatla.

The ferocity of the son of Boiyane!

It is like that of a lion which tears a man to pieces;

I pulled him away—I removed him from the spot where he died so that his people should not doctor either the place or the trail of Ntshonyana.[7]

The black cow [8] from Kgopu-ea-ga-Tshwene, which also comes from Kgopu-ea-ga-Moatlhodi, no longer requires medicine

Because it goes ahead of the red-and-white ox with the horns, the one which belongs to the Masweu kgotla.

Ramosilong,[9] rebuke your elder brother:

Rebuke him? what shall I say to him?

[1] Son of Mangope by junior wife.
[2] Father of Sebogodi, viz. Mangope.
[3] Phōkō-a-Boiyane.
[4] To the East of Thèbè Shuping's (Transvaal).
[5] Refers to the Bakgatla.
[6] Refers to Phōkō-a-Boiyane.
[7] Elder brother of Phōkō.
[8] Phōkō-a-Boiyane.
[9] Younger brother of Phōkō.

Shall I find fault with a brave man who, when the others ran away, stood his ground, who remained and stamped his feet at the foot of the Motlabatlaba hills?
The cow is stung by flies, Tsetlaki,[10] over there, at Malete-a-Badimo's.
I was attacked by Kgafela's people, Motlotle and his companions, who threw their bark-bound spears at me.
And you, Motlotle, are you a man?
Do you learn to throw your spear by copying me?

[10] Phōkō-a-Boiyane.

Praises of Mmolotsi-a-MmaPooè.

(After repulsing a BaTlokwa raid on the Ba-ga-Malete cattle.)

Kutuku e dumang,
Kgomo ea ga monna kgosi, ea ga monna Rra-Keepyang.
Kgomo e ncho e tlhabetswe bagale,
Tse di tsweu di tlhabèlwa magatlapa,
Di tlhabetswe mapyèga a Lehurutse,
A e se ke e re ba tsaba ba tlhōma thebe.
Somo la ga Lerigana a Rra-Kgori.
Ga le na maoto, ga le tshabe,
Le bulegetswe ke sefakō bolea.
Ke phefō e tshètlha,
Ke Mogōfu oa saka la Badimo,
Eo Mma-Maleka, eo Lesèlè.

The rumbling which is like the roll of thunder,
Ox belonging to the younger brother of the chief and to Rra-Keepyang.[1]
The black ox is killed for warriors to eat,
White ones are killed for cowards, such were killed for the arch-cowards from Lehurutse, who stood their shields up when they ran away.
The company of Lerigana, the father of Kgori,[2] has no legs and cannot escape for it is frozen (into immobility) by the coldness of the wind.
I am the wind that raises the yellow dust,
I am the rhinoceros from the Badimo cattle-post,
Son of Mma-Maleka and nephew of Lesèlè.[3]

[1] Rra-Keepyang, older brother of Mmolotsi.
[2] Kgori, a MoTlokwa.
[3] Mma-Maleka, a Molete woman, mother of Maleka; Lesèlè her sister.

Praises of Modingwane-a-Mokgōgwe-a-Pooè.

(After a raid on the Ba-ga-Siko, led by Pooè and Modingwane.)

Sekete se boima, kgolo e mositō mogolo,
Kolwane ye le tona, Ragaafele:
Ye le matsomane ekete a Modimo,
Ye eareng le rèma, Modimo o rèmè;
O rèmè ditlhokwa, morwa Kgosi,
O rèmè ditlhokwa, motho oa matlhomo.
Mosadi ke wèna, Mma-Modingwane,
Ribolola baswagadi ke fitlhile,
Ka itse se ikgōrōsitse sekopa
Segōgōu sa ga segopa marumō:
Monna ga bolokwe a le marumō,
Sōmō yabo ea bo e le marumō a gagwe
A a mo thebeng ea gagwe.
Tau e gatile setlhabakolobe,
E gatile sekgalotshe, morwa Kgosi.
Tau e letse le lenyōra le tlala,
E letse e sa nwa, Mma-Madueng.
Kgomo di kile tsa lela mogogoma,
Tsa ba tsa boa tsa lela mogogoma,
Tsa ètsa motshitshi o le 'logageng.
Sehularwane go a itse go tshaba,
O lebaganye le naka lwa tshukudu,
Ke naka lwa bodile o marapō.
Cheka-loine, eo o tlogang mokung,
O tloga go more o manaka-nake;
Lechèchèlè la gago, Rasèisō.

The rumbling is deep and reverberates like the tramping of many feet
Splendid young man that you are, Modingwane;
Your speed is like that of God Himself and when you chop (with an axe)
 it is like God chopping;
Cut the tall stems of the grass, son of the Chief,
Cut the tall stems of the grass, man of many parts.
A true woman are you, mother of Modingwane,
Cease mourning for I have arrived,
Know that the wounded one has brought himself home,
The maimed one who snatched the spears thrown at him, who broke them
 and hurled them back like knob-kerries:

The man who is wounded is not rescued, but his companions become as the spears which he keeps inside his shield.
The lion trod on burweed and on the small Mokgalo, son of the Chief.
The lion spent the night thirsty and hungry, he passed the night without drinking, Mma-Madueng.
The cattle lowed, they came back and continued to low, they were like a swarm of bees in a cave.
He knew how to outwit Sehularwane,[1] being like the horn of a rhinoceros, a horn as strong as a buffalo.
Modingwane, who left the shelter of the tree with branches like so many horns,
Your Lechechele,[2] Mokgōywe.

[1] The Mo-Siko whom Modingwane killed.
[2] Member of the Machechele age-unit.

Praises of Chief Pooè-a-Mokgōywe.

(After the defeat of the Ba-ga-Siko.)

Kgobodi, noga eo mogōga mogolo,
Ke nōga eo Mongatana-a-Maoka,
Nōga eo Motala-a-Marumō,
Eo Motala le Nkwè-a-gae.
E ntse ea itoga semelemete,
Mo motlhaleng oa kgomo tsa ga Siko-a-Ngwedi.
Baeboni ba rile e dule eōtlhè mo mosimeng, ise e tswe eōtlhè,
E ntse ea bolaea marutlhatsana.
Ramagōgōba oa noka ea Madikwe,
Eo gapa dikgomo a gape le batho,
A ba a gape le megolasetswana.
Phètlhèdi oa seja kgomo tsa merafhe,
A ba a gape le badisa ba dinamane.
Ne! u gapa yaana Lekgonata-letsho?
U gapa yaaka Mathèbè-tshwaana!
U yafe u re u di gapa Tsheledi
BaKwena ba bo ba etile ba leō, ba etetse Mogōge,
Ba etetse morwa Mankga-a-Pula;
Ba re ba fitlha ga bona ba bolèlè,
Ba re motho o kwa Madikwe.
Ramagōgōba oa ga matsaa-gotlhè,
Eo o gapa dikgomo a gape le batho.
Maraka a sala a tsalèla bothèpè,
Go sale go tsalèla mokgwerenyane.

Magōsanyana a mangwe lo a aka,
Lo ntse lo re raea lo re lo dikgosi, lo aka;
A lo raea go bo lo apere phokoye?
Malela di gangwa lo mo apèsitswe.
Bo kwena thatswane, lo dikwenanyana,
Loa loma kgomo e be e sepele,
Tlang lo bone kwena ka e lomile,
E utla, gore tshele, go èla ruri,
Le letshetse le tlhōka le go bonala.
Kgomo tsa gagu di mahulō, Tsheledi,
Ne! mahulō di a tsere kae, Tsheledi?
A bo re itlhōma di seka tsa siana,
Di ntse tsa khikhia go se go nene!
Thamaga di mahulō a dihubeng.
Ne! erile fha go tlhayōang monnao,
Fha go tlhayōang Modingwane tlhōgō,
U ne u le ntlheng efe, Tsheledi?
Tsheledi oa ga lengaparèla ntwa!
"Ke ne ke le ntlheng, ke kakègile,
Ntwa tshita e bōka e ntshetile!"
Kgomo ea lela ea tshwōbetsa molomo,
Ea ntsa tlhōgō ka thèko tsa marumō,
Ea huhumetsa tlhōgō mo marumōng.
Ga re a rialo, ga re a e bōna,
Re utlwile Phalwane a e bolèla,
Re utlwile Phalwane-oa-ga-Shwadile,
A re kgomo e mo go tsōnè e logala,
Ga e batle namane, e lela fhèla,
Namane ea eōne re e e neetse.
Khunwana ea dira matlhwaa letswalō.
Dikgomo tse di fha Ootsane monnye,
Le tse di kwa Magōkōtswane, Phètlhèdi,
Re ntse re re tsa gagu tsōtlhè,
Phètlhèdi oa seja kgomo tsa merafhe,
Phètlhèdi oa bo Rra-Nthèkè le Those.
Lentswe le tsenye ka Tlhabèlang,
Eare le fhitlha la tlhaba Ba-Rolong,
Le tlhabile barwa Tlou-a-Mokgopha,
Ba tsaba, ba phatlalala, Ba-Rolong.
Mokudumane o wetse ga Mawèbu,
Mosweu a gopola Didibaneng.
Bo Boa ba ntse kwa Mahididye,

Ba ikgõgetse kwa makalakaleng,
Ba lala ba bona metsi a tsamaea.
Kwatai oa ga rra-ngwana a Mogotsi,
A u ne u sa rialo, ua di gapa?
U sa rialo ua di tsaea tsõtlhè?
U sa rialo Kgopa-a-bo-Meno?
Marakanyana a sala a tsalèla bo khuku,
Ga sala go tsalèla mokgwerenyane.
Ngwana oa mosadi a ga Nare-lohètla, loa ga Segopadithamaga.
U gopa ka lone kgomo tsa merafhe,
Kana u yafile seng ua thiba Makaba,
Ua thiba bo Nkgogorupe-o-Kgotlana,
Bo Kgatlana-a-Motsièlwa,
Ba ba tlhako di tlalang megocwana ea batlhanka.
Mosoma di tswele u di yele,
Dithupa tsa tsõnè u batile ka tsõ,
U batèla bo Mma-mogocwana,
Eo o kwa ga Monoko.
Mmantidi eo o tila marumõ,
Eo o tila kgotshane tsa Ba-ga-Siko;
Mmantidi oa dinoka tsa bo Mainèlwè,
Oa dinoka tsa bo Phalalwè.
Phètlhèdi oa seja kgomo tsa merafhe,
Mmantidi-a-Ralepetekwane.

Pooè, Great Snake that resembles an army wending its way along, leaving a broad trail where it has passed through the grass,
I am the son of Mongatana-a-Maoka, of Motala and Nkwe-a-gae,[1]
The Snake which keeps its coils together when it is on the trail of the cattle of the Ba-Siko.[2]
Those who saw it said it had all come out of the hole, but it had not all come out and it is still bruising the small Morutlhare trees.
Pooè of the Marico River, who captures people as he captures cattle, who also seizes the long kraal hooks: [3]
Pooè who eats up the cattle of all the tribes and even captures the calf-herds.

[1] Mongatana was an early chief of the Ba-ga-Malete; Motala and Nkwe-a-gae were noted warriors.

[2] Ba-Siko or Ba-ga-Siko: tribe subjugated by the Ba-ga-Malete—*cf.* Historical Account, p. 39.

[3] At each cattle-post were kept long sticks having a hook at one end—these were used for catching wild or restless cows at milking-time, the hooked end being inserted into the animal's nostril.

So that is how you plunder, Black man!
You plunder like the Mathèbè-tshwaana.[4]
You were fortunate that when you seized them, Pooè, the BaKwena were here on a visit to Mogōge, the son of Mankga,[5] for when they reach their homes they will relate what they have seen, and speak of the man [6] who lives at the Marico River and seizes everything, including people and cattle.
The kraals remained deserted and became overgrown with wild spinach since the Namaqua dove nested there.
Some of you smaller Headmen, you lie.
You have been telling us you are chiefs, but you lie.
Do you mean to say that you are chiefs because you wear the jackal skin?
The jackal cries at milking time because you wear its skin.
You are little crocodiles of the small species, you bite the cow while it is walking out of the mud—
Come and see how the crocodile bites, it snaps, it submerges and disappears and not a bubble is to be seen!
Your cattle are frothing, Pooè.
Now, what are they frothing for, since we know that they have not been running and they barely stampeded?
The red-and-white oxen have froth-covered breasts.
Now, when your younger brother Modingwane was stabbed in the head, where were you, Pooè? You who delight in fighting.
"I was on the other side, hard pressed—I was on the horns of a dilemma."
The cow raised its voice in a high-sounded bellow, it thrust its head through the forest of spear hafts, it raised its head above the spears; we did not say so, because we did not see it, we heard of it from Phalwane.
We heard Phalwane, the son of Shwadile, who said,
"The cow is amongst those people and it is very angry, it does not want its calf, it just lows.
We have given it its calf—the red cow of war is heard a long way off."
The cattle which are at little Oodi,[7] and those which are at Magokotswane,[8] we have always said they were yours, all yours, Pooè;
Pooè who eats up the cattle of all the tribes;
Pooè, of the family of the father of Nthèkè [9] and Those,[9A]

[4] Regiment which carried white cow-hide shields.
[5] Mankga was the head of the Kgōrō bearing his name.
[6] Pooè.
[7] Ten miles north of Gaberones, B.P.
[8] Between the Marico and the Klein Marico Rivers.
[9] Nthèkè is a popular and revered name amongst the women of the Ba-ga-Malete.
[9A] Those (?).

The sound of the voice travelled beyond Tlhabèlang,[10] and its arrival startled the BaRolong, causing consternation amongst the sons of Tlou-a-Mokgopha.[11]

The BaRolong took fright and scattered—those of Kuruman ran to Mawebu [12] while Mosweu fled towards Didibaneng.[13]

Poane's people went to the Mahidiywe hills,[14] they struggled up to the crest, where they rested, and saw the attack withdraw.

Pooè, son of the paternal uncle of Mogotsi, did you not say so and seize them?

Did you not say so and take them all?

Did you not say so, Pooè?

Scavenger beetles bred in the little kraals; the Namaqua dove nested there.

Son of the wife of Mokgōywe,

Mussel-shell with which the red-and-white cattle are gathered in,[15]

With it you gather to yourself the cattle of all the tribes,

How cleverly you seized the big pack-oxen, those with the long horns belonging to Kgotlana [16] and those of Kgatlana-a-Motsièlwa; [17] those whose large feet filled the pots of the servants.

Mosoma,[18] you had had them quite long enough,

You paid with them for your concubines,

You rewarded MmaMogocwana and her sisters,

MmaMogocwana who lives at Monoko.

Pooè, who avoids the spears of the Ba-ga-Siko;

Pooè of the rivers near the Klein Marico and the Phalalwe;

Eater of the cattle of all tribes,

Pooè of Ralepetekwane's kgotla.[19]

[10] The lone hill east of Ramatlhabama.

[11] Presumably the Ba-Ratlou section of the Ba-Rolong.

[12] South of Kuruman.

[13] South of Kuruman.

[14] South of Kuruman.

[15] Literally "scooped" in.

[16] Ba-ga-Siko.

[17] Ba-ga-Siko.

[18] Mosoma was chief of the Ba-ga-Siko at the time this tribe was vanquished by the Ba-ga-Malete.

[19] Ralepetekwane's kgotla, otherwise known as that of "Boo rra Senyarèlo," was a small kgotla in the Chief's (or Kgosing) ward.

Praises of Nkwe-a-Magōgwe.

(After the assault on Ruthwane's village, in which Nkwe slew Ruthwane.)

Lophalole la gago, Rra-Soofhèla,

Mampshe wa loala la mosii;

Mpshe o tsenye molapō kateng,

Mme ga lo a re o tsetswe morago Magata a tsetswe;
Mme ntlha o tsela noka tsōtlhe, Magata a ise a di tsele,
Ka a ikitse a latèlèla Ruthwane-a-Mokgōywe-a-Madibana,
Wa gago Phitsana-a-Magōgwe.

Your tall and lanky son, Rra-Soofhèla [1]
Mother of the ostrich, the fastest runner to reach the grindstone;
The ostrich went into the bed of the river, but you did not admit that he was born after the Magata,[2]
Yet it seems that he crosses all the rivers before they do,
For he was sure of himself when he set out to kill Ruthwane.
Be proud of him, Phitsana-a-Magōgwe.[3]

[1] Magōgwe, fourth son of Pooè-a-Marumō, father of Nkwe-a-Magōgwe.
[2] Members of the Magata age-unit.
[3] Sister of Nkwe-a-Magōgwe.

Praises of Marope-a-Rakgomo.

(After repulsing a raid by the BaKgatla on the Ba-ga-Malete cattle.)

More o o ōbe di botlhoko
More o kile oa kgwèlèa setlōpō
Oa bo oa tswara tlōpō sa ga Khuku-a-Modimèlè
Maloba yale ka ntwa ea bodiba.
Ke kgalemetse Ragare, a siana,
Ke lesitse Motse-o-nageng a fheta,
Kare, "tloga thata u e go latola batho;
U latole bo Monako-a-Mafhata,
U bolèlle Matsolakhudu a Kgatleng,
Bolèlla Kontlè le Mookodi,
U re kwano thaka ea Matshuba re a fhetolana."
Ga re tlhole re katuma Mafhatswana
Matsolakhudu oo Rra-Ntlatseng.
Re etsa fha mung a le reshomèla
Maphalaole a rile atlarèla
Fha re ntse re re "gashu," re itatswa letlhole
La kgomo eo Mongatana-a-Maoka.
BaKgatla, lo no lo ya lo gadima,
Lo boloke motho o koo, o lo thusitse
Erile ka dira a upa sefhako;
A upa phefo eo o Rra-Ntlatseng;
Fha e fhoka thata thata go le botlhoko,
Fha kgotlantsa magodiri dilela
Gontse go re 'tsikitsiki' ka fha ga Nare.

Lo itlhōma lo tla fhèla, BaKgatla.
Ba ga Mpya e ya ntyana.
BaKgatla ba boi, ba tsaba Marope,
Batlhomi gotèwa Marope a motho
Ntswa re raea marope a kwa ga Ramodibedi.
Rasemathu o tsamaisa moloi,
Molefhè o sepètsa kgatadirite eo nyeletsa batho.
Dikgomo ba gapile tsōō Tauna,
Ere fha go tsōō Tau re ganè, re ba re lalè.
Kana setlane se bolèlwa e le eng
Fha gotwe maraka a tsōne a yalwa marōtse
A eme a goreletse Magadimo
A lebeletswe ke tlhōkwa la mosèka.
Malema ke tsèbè oo Ntlatseng.
Ke mpshe eo mosweu, O Nthatana, O Tlotleng, le Dibuō.
Leina lengwe la ga kgatadirite,
Leina yeo u se ka oa le bōka re na le batho;
Tseo dintwa di a bo ditimèla dikhutla.
Kana re tla aga re nna tebelele
Re be re ōpana ka mabōgō magètla.
Gakale oa ga Seinyana.

The tree with hooked thorns is a cruel one.
The tuft of hair on the crown of Khuku-a-Modimele's[1] head was caught by such a one the other day during the fight at the lagoon.
I rebuked Ragare,[2] and he ran all the faster,
I allowed Motse-o-nageng[3] to pass, saying to him,
"Make haste, go and report the death of your people,
"Announce the death of Monako-a-Mafhata[4] and his companions, tell the Matsolakhudu[5] BaKgatla,
"Tell Kontle[6] and Mookodi,[7]
"Say that here, the company of Matshuba[8] are in a quandary."
No longer can we, the Matsolakhudu[9] of the father of Ntlatseng,[10] give way to the Mafhatswana.[11]

[1] BaKgatla warrior.
[2] BaKgatla warrior.
[3] BaKgatla warrior.
[4] BaKgatla warrior.
[5] BaKgatla age-unit.
[6] Chief of the BaKgatla of Manaana.
[7] Younger brother of Kontlè.
[8] BaMalete age-unit.
[9] BaMalete age-unit of same standing as the BaKgatla "Matsolakhudu."
[10] Mokgōywe-a-Pooè.
[11] BaKgatla age-unit.

We are acting as if we had the consent of our leader.

Maphalaole said we should receive with both hands, and we were still licking the blood and fat off our fingers and eating greedily (noisily) of the meat of the ox given to us by the chief.

BaKgatla, you kept your weather eye open while you ate, take care of the man[12] over there, for he assisted you during the fight by warding off the hail stones;

He, the father of Ntlatseng, charmed the wind, for when it blows very hard it is a bitter wind—the branches of the Mogodiri trees rub one against the other until they creak and one hears only "tsikitsiki" in the direction of the village of the BaMalete.

If you are determined upon your course, BaKgatla, you will perish, for the warriors of the Mpya Kgõrõ[13] eat up little dogs.

The BaKgatla are afraid, they fear Marope; those who are sure mean Marope the man, although the word also refers to the ruins at Ramodibedi.[14]

Rasemathu[15] deals in witchcraft while Molefhe[16] leads him on as he jumps from tuft to tuft so as to leave no footmarks—the wizard who causes people to disappear.

They captured the cattle of the Tauana kgotla,[17] but we refused to surrender those of Tau[18] (we fought all day) and then slept, but what kind of explanation can we give when it is said that pumpkins are grown inside the kraals, when the cattle just stand and gaze at their kraals, guarded by "the stalks of the grass from which bracelets and bangles are made"[19]—when they stand with their ears pricked up, O Ntlatseng?

I am the white ostrich, O Nthatana,[20] O Tlotleng,[21] and Dibuõ.[22]

That is another name for the wizard, but beware if you praise him under that name in public, for such things are apt to cause strife when least expected.

We shall build a village and live in peace.

[12] Pooè-a-Mokgõywe.
[13] Mpya = a dog.
[14] Former BaKgatla settlement, 10 miles N.E. of Dinokana.
[15] Marope.
[16] A Molete, son of Motshwaedi of the Moeng Kgõrõ.
[17] Tauana = little lion. One of the tribal sub-kgõrõs.
[18] Tau = a lion. Name of one of the Chief's cattle-posts.
[19] Marope refers to himself.
[20] Chief Pooè-a-Mokgõywe.
[21] Marope's sister.
[22] Moswete, Marope's cousin.

We shall sing and pat each other on the back.
Full of zeal is the son of Seinyana.[23]

[23] Seinyana, mother of Marope-a-Rakgomo.

Praises of Chief Mokgosi-a-Pooè (Mokgosi I).

I. Kgodumo e dikgōpō,
Nare eo Sebitsō le Nthomang!
Ga e ke e leba motho a tswa motho
E nne e lebè o shuleng fhèla.
Ne! ngwana eole ke ngwana oa ga mang
O nntse a ègwa ke loyalape?
Ke tau ea namane!
Ke bata se se mokōkōtlō montsho!
Rragwe a tloge ka go tlhoboga
Mmagwe a lelè e sale gale.
Ke tlou e ntle ea Mapula a kgosi,
E ntle ntle e e mo Matsaakganye.
Ga e èpè e tlhōla e ikemetse
E eme fhèla mo motheōganeng
E itsa dinaka go tlaa robèga:
Segope eo dinaka di tshwaana!
Bolèlèla Raditshwaana, Tshukudu,
U utluise Monametsi, Patakèla,
Phōlōgōlō e maboa a dikgong, e maboa maleele mabōgōng.
Leru la duma fha ga Molatedi,
La re le duma la thubaganya motho—
Le thubile Mphete oa ga Marwala.
"Mphete ga u a ka u a itse go tshaba,
"U rile u tsaba u a etsaetsèga, u lebaganye le naka lwa Tshukudu."
Tau e tswa lwapeng e tlhanyere marumō,
E tswa lwapeng la ga Seriba-a-Sebitsōnyane-a-Phuti
E le thèbè tshumu, morwa kgosi.
Lerumō la thipa, lerumō la pitsō,
Ga le ke le timèla ele la kgosi;
Motlhang le timèla le a re beka,
Ba dintlha tlogang lo le batleng,
Thata le batlwe ke boo Marungwana,
Boo Tauana lo ba sale morago,
Boo Moeng le bona ba le teng.
Ere mariga a tsèna, lo tshube phèfère,

Lo tshube bo Madikwe bo Lokgololo
Eo tlhaga ea goetla e fhitlha marumō.
Le ka kwa Madikwe ba ile ba le tlhōka
Ba ile ba le bōna kwa Kgololong.
La noga e ntsho eo Ra-Kedimotse, ntsho eo Ra-Moetshwe le Phetwe.
Me, erile ka e le matlho a bogale,
E matlho a ntlha e bonèla ruri,
E bonye batho ba sa oma mogōtlhō o Masoufala o tlhaga,
Ea letsa ditlhako e ba lateletse;
Ba latlha ditlhako, ba latlha marumō
Ba tlhōka mosima oa go bo ba tsenye.
A thota e, eo Kgobōdi-a-Mokgwa
E, eo Pooè-a-Marumō,
A ke eōna botshabèlo yoa dichaba?
Pōō o ntse a lo botsa logong
A lo botsa Monametsi lotlharapa
Tlharapa lo lo mo Matsaakganye;
A re "Ne! monongwaga lo letse kae, logong lwa malala-kgotodueng!"
Ngwako a neetse tlhaba Motshwaèdi
O neetse mpya tsa gagwe pudumō,
Pudumō eo maswe ga e ke e fosa.
Mathèogele o lwetse dipududu
O lwetse dikgomo di tloga le batho.

II. Lentswe le bokete, bopelepele ya lefhika,
Lentswe-Tshipi le palletse merafhe.
Le palletse bontsintsi ya batho.
Chaba di rile di phutègile di tsile go leka lefhika,
La fitlha la retèla lentswe-Ngope.
Lentswe-Tshipi yoo Rra-Ntlatseng
La re "Kaitswe, ke monna, ke tla pala,
Ga nkake ka lekwa ke basimane,
Ke fhatlogile le bo-rra eno,
Ke fhatlogile le Tshosa-a-Moleta."
Lentswe le kile la palèla Ba-ea-Setsho,
Go no go le BaKgatla ba Logapane,
Go le BaKgatla ba ga Ramodibedi,
Go le Kgari, ngwana ga Macheng,
Morwa Mangope le ene a le teng.
Motho Shuping o matlhong go thata,
Re ntse re mo nyatsa re re o latlhile mogolowe

Ntsenka o bona e le makailwanyane.
Tshona Kontle o sikere mopakō,
O paketse barwa Mathwanyana,
O o sikere ka mbolosanyana,
O ntse a ōmangwa ke Bodibe,
Sefere le ene a mo gakaletse,
Bathoeng a mo shupa ka monwana, a re
"Seo gwana sa me ga se ke sa thubywa,
U ka se thuba u ka bona ga dilō,
Tsoo rrago di ka fhèla sakeng:
Go ka tswa kgweba e tsebe di manyèna,
Letlole le ene a e ntsa yalo,
Kwalate le ene a e ntsa yalo,
A lefèla ngwana ga mogolowe."
Bathoeng, kea gu nyatsa, ebile kea gu leboga,
U yafile seng, ua ntsa bontsi yoa batho,
Ba tla gu bōna, ka matlhō, ba tlhobogo;
Me ke bile kea gu nyatsa,
Ka u seka ua bolella Thobèga,
U lobetse morwa Mokhibidu,
O tla nna a tsenwa ke bosilō.
Nna ke utluile basadi ba tswa tsopeng,
Ke utluile basadi boo rra Modingwane, ba re
"Malōba o na a ōmana le Lophunyaka,
A re 'lona lo ikantse mang?
A bo rona re ikantse Sechele,
Ka re lema mabèlè re a mo nneele.'
Me Lophunyaka ga a ka a mo leseletsa,
O mo reile a re 'Rona re ikantse Modimo,
Re tla engwa ke Modimo nokeng.'"

III. Le bogologolo yole ke bo tlagang,
Ga ke ise ke bōnè tauana e bōpa,
E bōpa e betelela ntsikile,
E betelela Ramasigogaase,
A tlhōma a itsikinya ntsikile,
A tshaba a phatlalala madumedi
A lebile Hudiri-la-ga-Morepō.
Kgomo e tsaletse mo Sengomeng,
E gangwa ke Mokgōywe le Mokalake,
Morwa Sefera o tsile a e leka,

Ea mo tshwara, ea mo gagolèla dikobo.
Ramakuka u bōka u gabaletse,
U re u le mosimane oa Kgosing
U bōka u tshwaraganye difogole
Leina setlhako le phatlolwa fhela.
Tshilwana e ka ntswe, kgolokwane ea ga mogatsa Sebati.
Rumo la me le latlhegetse koo Ba-diphakana
Ere moira le pelo a le nthwalele,
Eo o sena pelo a lo ise koo.
Re tlhotse re goga motsokwe mmōgō le Ba-diphakana,
Molamu o tlhōgō kgolo, oa ga Rabasia-BaKgotu,
Nka konopa ka one, nka fosa.

I. Mokgosi, Buffalo with the big ribs,
Father of Sebitsō,[1] and brother-in-law of Nthomang! [2]
Man is no longer a man when the buffalo has done with him, he is but a corpse.
Whose child is that over yonder,
The child that struggles with the lion?
I am the young lion!
The wild animal with pad-feet and black back!
Whose father has given up hope from the beginning and whose mother has wept for a long time.
I am the fine elephant of the Mathubapula,[3] the finest elephant in the Matsaakgang.[4]
It does not root about, but just stands by;
It just stands at the top of the slope, refusing to risk breaking its tusks;
Elephant of the white tusks!
Tell Porogwane,[5] O Rhinoceros.[6]
Bring it to the notice of Monametsi,[7] Patakèla,[8] that the animal has bristles and long hairs on its arms.

[1] Eldest son of Mokgosi by his sixth wife, Thoto.
[2] Sister of Seriba, Pooè's "great" wife, and of Mmelesi of the Moeng Kgōrō.
[3] Ba-ga-Malete age-unit: Leader Mmolotsi.
[4] Ba-ga-Malete age-unit: Leader Mokgosi.
[5] Eldest son of Mokgosi by his fifth wife, Matlafèla.
[6] Mokgosi.
[7] Son of Nkwe-a-Magōgwe, viz. Magōgwe, fourth son of Pooè-a-Marumō; Nkwe-a-Magōgwe, son of Magōgwe; Monametsi, son of Nkwe-a-Magōgwe; Disèko, son of Monametsi; Magosi, son of Disèko; Radikota (present head of the Madisakwane Kgotla), son of Magosi.
[8] Mokgosi.

The cloud thundered in the direction of Naauwpoort,[9] and as it thundered, a man was rent asunder—

Mokgosi killed Mphete the Mohurutse.

"You did not know how to escape, Mphete—when you tried, you just ran hither and thither and impaled yourself on the rhinoceros' horn."

The lion comes out of the court-yard and seizes its spears:

It comes from the house of Seriba, the daughter of Sebitsõnyane-a-Phuti.[10]

Like a white-faced shield is the son of the Chief.

The assegai, which is used for skinning animals, and the symbol of the lecholõ,[11] can never be lost since it belongs to the Chief:

Should it be lost, fear will grip our hearts—

You who live nearest the Chief, get up and look for it,

Particularly must you of the Marungwana kgõrõ look for it.

Those of the Tauana kgõrõ must join in the search,

And you of the Moeng kgõrõ must be there too.

When winter comes, burn the grass,

Burn the reeds in the Marico and Lokgololo rivers for the autumn grass conceals the spears.

In vain did they search for it in the direction of the Marico, but they found it near the Lokgololo.

The spear of the Black Snake (Mokgosi), the son of the father of Kedimotse, Moetshwe and Phetwe.[12]

But, as it had sharp eyes that saw better than others, it saw the people before they started climbing Masoufala's [13] camelthorn tree (the one with the white seed pods), the top of which was just visible above the ridge; in following them, it made a noise with its feet, they cast away their sandals and spears but could not find a hole to hide in.

Mokgosi, descendant of Mokgwa and of Pooè, is that ridge the retreat of the tribes?

Pooè keeps on asking you about the sapling,

About Monametsi, the tall young man of the Matsaakgang.

He said, "Well, where have you been this year, tall one who sleeps amongst the shrubs which bear the small red flowers?"

[9] On the Mochudi-Saulspoort Road (Transvaal). Farm Naauwpoort—a day's walk from Gaberones. ? No. 150.

[10] Seriba = Mokgosi's mother.

[11] Tribal meeting to which all men come armed.

[12] Mokgosi's brothers, *cf.* Genealogical Table.

[13] A Molete (Masoufala's camelthorn tree).

Mokgosi gave his spear to Motshwaèdi [14] and sent his dogs after the gnu—the gnu does not miss with its horns!

Mokgosi fought for the dark blue cattle, he battled for the cattle which were in danger of being captured.

(After the BaNgwaketsi attack on Ramoutsa 1881.)

II. The Stone [15] is heavy, it is very heavy and offers no hold;

The Stone of Iron is beyond the strength of all the nations,

It has proved too heavy for many, many people.

The nations assembled to pit their strength against the Stone, but they found it wholly unyielding.

Mokgosi, the son of Pooè, spake thus:—

"I am known to everybody—I am a man, I will yield to no man, and it is puerile for boys to try and move me; I grew up with your forefathers, with Tshosa-a-Moleta." [16]

"The Stone proved too much for the Ba-ea-Setsho.[17]

"The BaKgatla of Manaana were there, also those of Ramodibedi; [18]

"Kgari, the son of Macheng,[19] was present, also the son of Mangope.[20]

"Shuping,[21] the man with far-seeing eyes—we were still scorning him, thinking that he had abandoned his elder brother—seemed to sense that this man [22] was but of small account.

"Kontle [23] was carrying a burden.

"He was carrying water for the sons of Mathwanyana,[24] and he carried it on a thin, smooth little stick.

"Bodibe [25] kept on reproaching him, while Sefere [26] made him angry.

[14] Head of the Moeng sub-Kgōri.

[15] Mokgosi.

[16] The father of Chief Gaseitsiwe of the BaNgwaketsi.

[17] BaNgwaketsi. The reference is to the second degree of initiation (the Black Initiation, see Willoughby's *Race Problems in the New Africa*, p. 132). Apparently only the BaKwena, BaNgwato, and BaNgwaketsi (also the Ba-ga-Siko) carried out the Black Initiation, to which even married men were admitted.

[18] The site of a former BaKgatla settlement at or near Tswenyane, some 10 miles north-east of Linokana (Transvaal).

[19] Macheng was brother to Sekgoma I, the father of Khama III. Kgari lived and died at Ngomare, near Kanye, in the BaNgwaketsi Reserve. Kgari's son Makakatlele is living there now.

[20] Mosièlèlè.

[21] Son of Kontle and grandson of Mangope of the Bahurutse.

[22] Bathoeng I.

[23] Son of Mangope, Chief of the Bahurutse (boo Manyana).

[24] A former Chief, Makaba I, of the BaNgwaketsi.

[25] Bodibe = a MoNgwaketsi (?), son of Mongale and grandson of Makaba, Chief of the BaNgwaketsi.

[26] Sefere = a MoNgwaketsi.

"Bathoeng pointed his finger at him, saying,
"On no account must my water-pot be broken.
"If you break it you will get into trouble:
"It might cost your father [27] all his cattle,
"The fine might be all the speckled oxen bearing the Manyana ear-mark.[28]
"Letlole [29] would have to pay the same, Kwalate [30] also, to satisfy the fine imposed upon the son of their elder brother.[31]
"Bathoeng, I despise you—at the same time I thank you, for you have done well to bring so many people—they will look to you and turn back in despair.
"Yes, I despise you, because you did not tell Thobèga,[32]
"You did not tell the son of the Mohurutse, and foolishness will mark his actions.
"I heard the women returning from fetching clay:
"I heard the women of Modingwane's kgotla [33] saying,
"The other day, Thobèga was reproving Lophunyaka [34] and asked him: 'Who do you and your people acknowledge as your chief? We owe allegiance to Sechele [35]—we grow corn and give him some of the crop.' To which Lophunyaka replied, 'We acknowledge God and He will stand by us.'"

III. Ever since I was born, and that was long, long ago,
I have never seen a young lion [36] attack a full-grown lion.[37]
I have never seen a young lion [36] attack and master a full-grown lion.[37]
I have never seen a young lion master a full-grown lion.[38]

[27] Mangope.

[28] The lower side of the ear was cut from the point of the ear inwards and allowed to hang.

[29] Paternal uncle of Kontle.

[30] Younger brother of Mangope.

[31] Under native law and custom, if a man cannot pay his fine, the members of his family, starting with his father, then his paternal uncle, and so on, always come to his assistance.

[32] Son of Ramodikwane and head of the Bahurutse section living at Mochibidu or Mankgodi, near the Kolobeng River.

[33] The founder of this kgotla, which is within the Chief's Ward or Kgōrō, was the son of Mokgōywe-a-Pooè by a junior wife, *cf.* Genealogical Table.

[34] Paternal uncle of Samuel Bolokwe, a Molete.

[35] Chief of the BaKwena.

[36] Bathoeng I, who had not long succeeded his father Gaseitsiwe as chief of the BaNgwaketsi.

[37] Mokgosi, Chief of the Ba-ga-Malete.

[38] Ramasigogaase = the allusion is to the fact that while young lions sleep during the day-time, the day never dawns for the full-grown beast, which is just as wide-awake by day as it is at night.

I have never seen a young lion getting its claws into a big one, shaking it, then taking fright and scattering the young lions in the direction of the ridge overlooking the Maokamatswane valley.[39]

A cow [40] was born at Sengoma [41] and was milked by Mokgoywe and Mokalake.[42]

The son of Sefera [43] came and tried to milk it, but it caught him and tore his clothes.

Ramakuka,[44] you make up praises although you are hungry;

You say you are one of the Ba-kgosing.[45]

You make up praises but, like a man who absent-mindedly undoes his sandals, you do not understand what you are saying.

The small grindstone is itself a stone, the small round stone of Sebati's [46] wife.

I lost my spear amongst the people living near the boundary.

May he who has a heart return it to me, for he who has no heart will not bother.

We spent a while taking snuff [47] with the BaNgwaketse.

I might have a shot with the knob-kerrie with the big head—the knob-kerrie of the BaNgwaketse and their allies—but the shot might miss its mark.

[39] Near Mahosi (Mokgosi) Siding, B.P.

[40] Mokgosi.

[41] The small hill south of the village of Ramoutsa, now on the boundary line between the Bechuanaland Protectorate and the Union of South Africa.

[42] Mokgōywe and Mokalake were Mokgosi's sons by his third and second wives respectively, *cf.* Genealogical Table.

[43] Sefera would appear to be one of the names by which Gaseitsiwe was known.

[44] Father of Ntwae, a Molete.

[45] Ba-kgosing = the members of the Chief's ward or kgōrō.

[46] Sebati was one of Mhatla's men.

[47] Comparing the attempt of the BaNgwaketsi to assert their authority over the Ba-ga-Malete with the pleasant recreation of snuff-taking.

Praises of the Ba-Ga-Malete Tribe (Chief Mokgosi I).

(After the BaNgwaketsi attack on Ramoutsa Village.)

Matebele a mantso a ga Masodi-a-Mphela!
A ga selala le namane letlhakoleng!
Di rōbarōba matlhakola
Di a robile fhèla di sa tla go a lala,
Di tsoga di gopola tlhakola longwe.

Di tlhaolèla nageng, namane tse di dinaka di di ōbe.
Ere fha e re "gou" e be e re "gōō," Kgodumō;
U e tshabèlè mo mogōtlhōng,
More oa Nare ga o lebalebèlwe,
Mutlwa ga o tshwane le lonaka, o tla tlhomolwa.
Mogatsa mmolaea-nare o ya a batla seantlo e sale gale,
Kgodumō e maboō mabe, go boa ea gabalala.
Barwa pataolō tsa mere,
Barwa motlhana o tlhōkile motsèi,
O yelwe ke magakabe le manong.
Barwa Kgodumō ea lesèlèsèlè!

Ho! dark skinned Matebele [1] of Masodi-a-Mphela! [2] which lie down with their calves in the motlhakola! [3]
They crash through the motlhakola thickets, laying them waste without thought of sleeping there, for they wake in the morning with other thickets in mind.
The cows separate themselves from their calves in the veld, calves whose horns curve inwards.
When the buffalo bellows "gou" it means "gōō," and you must flee from it into the camelthorn tree;
When you flee from it you do not pick your tree—a thorn is unlike a horn for it can be extracted.
The wife of the buffalo hunter expects daily to become a widow and her thoughts are turned towards a younger brother-in-law who will raise seed to her dead husband,[4] for the buffalo is a dangerous beast—when it turns round it charges.
Bull calves whose sire butts the trees with its boss;
Bull calves who have no one to remove the after-birth which is eaten by crows and vultures;
Bull calves of the Buffalo which lives in the masèlèsèlè thickets! [5]

[1] The double meaning assigned to words is a predominating feature of the Praises: here the tribe is lauded by reference to (*a*) the stock from which it is descended, (*b*) its totem animal, the buffalo.

[2] Masodi, child of Mphela, a Molete of long, long ago, a member of the Mpya Ward or Kgōrō.

[3] An ever-green thornless bush which grows in clumps or thickets.

[4] According to native custom a widow is taken up by her deceased husband's younger brother by whom seed is raised in the dead man's name.

[5] A drought- and termite-resisting tree which grows usually in close-set and almost impenetrable patches. The wood is extremely hard, and the tree is adorned with tough spike-like thorns. Mosèlèsèlè (singular), Masèlèsèlè (plural), Lesèlèsèlè (collective plural, denoting a group or patch).

Praises of Chief Ikaneng.

(Shortly after the initiation of the Mayapōō age-unit—1857(?)—when they killed lions at Tswaneng on the old transport road to Molepolole, beyond the Metsimotlhaba River.)

I. Morwa Mathèogele, petlo moshawa,
Petlo ea ditau monna Nthèkè,
Ea ditau, monna Ikalafeng.
Ke e gotlile ka lentswe malōba
Ka leshaba ke ntse ke le beile.
Lo maaka badisa ba Maitere,
Lo mphorile lo a re go duma pula;
Nna, erile ke di reetsa,
Erile ke di tlhaloganya go duma,
Kare ga go dume pula,
Go duma tsa makgwa,
Go a bo go bua dilo tsa dinaga—
Dilo tsa thota di matlhotlho a mantsi;
Ditau tsa Gabane, lo balotsana,
Ke lo utluile lo momura lo fhèta,
Nwe e bitsa e e kwa Senamakoleng,
E re "morwa Mathèogela o re sweditse,
Na, monongwaga o tla re pega kae?
Dikgata tsa rona di tletse moshung,
Di tletse mo kgotleng eo Marumō."
Rona ba-ga Malete re tsalelwa Kgosi,
Ngwana a kgosi ea rona o epa letsholō,
Ere ba dintlha ba itlhaganele,
Ba tloge ka pele, ba tle go reetsa,
Ba tle go utlwa e gelebetega Kgodumō,
Nare eo Sebitso le Mosikari.
Ntlha MmaMalete ga a tle go bogèlwa,
A tla go bōna, a tla go bōna ka Nare e bopile.
Re bopile moleta, moleta ra o emisa,
Mokala o molele oa ga Mokgwa.
A letsholo le epe di e go bolawa,
Dithutlwa di ipapetle le meruti ea mayè.
Go lale go sa yewa goo Marumō,
Go lale go segagangwa maumō,
Go segwa bo kwana ya kgomo, go segwa yoa phofu,
Go segwa yoa mamisi eo motona.
O sere o o fha, o fhe Meditsane le Maphakèla,

Ka itse ke bona ba tlhabana ntwa:
Kana ntwa e tsabya ke ditswerere,
Go sale go bolawa bo Maphakèla.

(After the BaNgwaketsi attack on Ramoutsa Village in 1881.)

II. Bodile oa Maratadiba,
Thama ea mampu, u lemile yang?
U rile u lema ua lema makōrō,
Naka tsa gagu tsa pitla sephapèla,
Dinaka tsa pitlaganya sefhatlhōgō.
Ka u ikitse u tla bolaea motho,
Ka u tlhabile monna oa Kgwadibana;
Ua mo tswara, ua mo gagola dikgōpō,
Kgōpō tsa gagwe tsa aga ntlahuhu
Tsa sala di kokonwa ke dikantsi,
Ke dikantsi ke dilo tsa naga.
Ka ele modisa oa magangwa o Sebego,
Tloga thata modisa oa Kgwadibana,
Tloga thata u e go latola batho,
U re, kana Bodile o leleketse koo.
O makōrō Bodile oeno Mokgōywe!
Oa makgala thipa, oa bo Moremedi,
Maimolole oa ga gabo Mma-Thatō,
O Mokalakane le Letebele,
O nama a re imolola bokete.
Ere bokete bo re ntse godimo,
Bo thibile kgōrō tsa bo Gaobotse,
Kwa go Moeng le gona bo le teng.
Fha mekgosi e lela machacha,
Bo Mpya ba ina mokoduane,
Ba kua bōtlhè ka bo-rra-Monametsi,
Bare, "ri imololeng, kwano re imèlètswè,"
A tle a bo imolole, ka ele seimolola-bokete;
Ka re ne re le pitseng, re apeilwe, re bile ra khurumelwa ka morifi.
Motho a kua kwa goo Mongala-a-Phage,
Are "tlang lo bone, motho o kwano, o wetswe ke disana.
Dikgong di bile di mo letse godimo,
O itlhomile a re oa go tshuba molelō."
Lerumo le mo tsenye ka mahihiri,
Le tsenye ka seperuperu sa gagwe.
Nna, kea mo itse, o nkgakile fhèla,
Ke mo lemoga ka lobadi loa tlhōgō,

Ka lobadi ele lotswao la motho.
Sebopo ekete morwa Lekgaua,
Nna, ba gaetso, ga ba ntsiètsè.
Go no go le BaKgatla ba Logapane,
Go le BaKgatla ba ga Ramodibedi,
Go le Kgari, ngwana ga Macheng.
Morwa Mangope le ene a le teng.
Morwa Pōō o fereletse mo marumōng, mo sechachalaleng,
Tshona re re kanna re re ineneketse.
U boè ka morago, ngwana ga Mokgosi,
U nte kgabo e tuke, e nye magala,
Ua bèkèga, motho o Marumō.
Are "keng ke ke she, ke tla phuloga,
Ke tla engwa ke Modimo nokeng,"
Ka a bona motse o rragwe o tshubywa ke batho,
Motse o tshubywa ke barwa Sekgèkgèthè.
Are "molelō tlhase o ya mootshubi,
Go tla sha monna o Mongala-a-Mathwanyana,
A sha a kudupana seletlalō,
A ètsa tlalō le besitswe isong."
Tshona Bathoeng ga hule, oa tètèsèla,
O sale a rengwa ke lentswe la ga Ikaneng,
A utlwa a kgalemèla dikgodumō.
Are "hulang thata batho bo Maiō, batho bo Mongatana-a-Maoka,
Lo hule thata, go simè:
Batho ke bao ba re tsènèla gae,
Ba re senyetsa motse re o agile,
Ba maaka, ba tla fhisa ntlo ea nwe fhèla,
O montsi re tla retèla ka ona,
Go bua Makobe-kobe oa ga rra Pōō-a-Mokgōywe."
Lorole loa ntwa ekete sefhakō, Tlhalatsi,
Ebile ekete marothodi a pula,
Marumō, ekete pula ea na.
Kgomo e rile "Phankga!" ka moletse,
Ea raga ea katikanya thamagana:
Kgomo tshwaana e ragile mogami,
E thubile kgamèlo mo mangoleng
Mashi a tletse letsotèlō, Tlhalatsi oa ga Mokgosi-a-Pooè.
"O rile a tsoga a ntse a hèma,
"A bile a iphimola dikeledi,
"Are 'ntlha e ka bo irile e bolola, ka ipata,
"Ka tlhotsa lekoto ka go e lema,

"Kare koto lame le bosisi, kea tlhotsa,
"Ke letse ke wetse mo tlhobolokong.'
"Lo re digetse, batho re sa ba itse,
"Re itlhōma e le morōgō a thèpè;
"Bao boo-Pooè, bo Kgamelo-a-Mmitlwa,
"Lo ba gamètse mo masutlhangkeng."
Kana lo kaa yang, batho boo Mongala-a-Mathwanyana,
Lo kaa lo forofōtlha Thamagana,
Lo e kaile ka phèkèlō e sele;
Lo maaka, e tla lo raga,
Lo kaile phōrōphōtle kgomo kgwana,
Nna, ke lonyatsi barwa Sekgèkgèthè,
Lo no lo nole khadi ea morètlwa, lo kgotse,
Lo ntso lo e menolosa, serètsè,
Ka mpa e sena motho ope, letlhale,
Lo itigetse mo nakeng tsa Nare,
Ea lo tswara ea lo gagola dikgōpō,
E lo bifhetse lo sa tlola Taung.

III. Pududu ea Maatswakgosi, ke tswarwe,
Tiifhatse o rile tiilentswe,
Tiifhatse o rile tiilentswe,
Pelo motlhaba oa naga, ke namile.
Kontle o rile "Ke tsala mafhatla!"
A re "Ke tsala MoNgwaketsi, ke be ke tsale MoKgatla, ke be ke tsale le Kgari ngwana ga Macheng:"
Kontle, a ko tsale gape, re bone.
Se tlatla se ba ya se nyelètsa batho,
Se ya mafhatla a, bana ba Kontle.
Lela u kgaotse Mma-Bathoeng,
Bana ba gagu ga re ise re ba bone,
Re utlwa gotwe ba ilé ga-Khunwana,
Fha re ka bo re ba bone, re ka bo re bone go gōga meeti.
Noka ea mola o mogolo, Ke tletse,
Noka ea Taung e robile sekèpè sa ga Kontle le Bathoeng.

I. Son of Mokgosi, the battle-axe is sharp,
The battle-axe lions are killed with, younger brother of Nthèkè,[1]
Lord of the lions, younger brother of Ikalafeng; [2]

[1] Mokgosi's daughter of the second house.

[2] Ikaneng's own sister, also known as MmaMalete, who married Mosièlèlè (Chief of the Manaana BaKgatla living in the Protectorate) and became the mother of Gobuamang, who is now settled at Ga-Thamaga, in the Bakwena Reserve, with a section of the BaKgatla.

I sharpened it on a stone the day before yesterday, using the scouring paste which I keep for that purpose.
You lie, you herds of the Maitere cattle-post,[3]
You deceived me when you said there was thunder:
When I listened and recognised the sound I said,
"That is not thunder but the roaring of the beasts of the forest,
"The wild beasts are talking—the things which live in the thickets are full of guile":
Lions of Gabane you are rogues,
I heard you growling as you went by,
One was calling to another at Senamakola,[4] saying,
"The son of Mokgosi has practically exterminated us, where will he hang us this year?
"The trees are laden with our skulls, and there are many more in the Chief's kgotla."
Our Chief is born to us, ba-ga-Malete,
The son of our Chief calls the hunt,
Tell those who live on the outskirts of the village to hurry, to hurry and come and listen, to come and hear the Buffalo [5] bellow,
O Buffalo, of Sebitso [6] and Mosikari.[7]
Why does MmaMalete [8] not come to see,
Why does she not come to see how the Buffalo shapes.
We produced a haughty person, but we suppressed his arrogance, the tall son of the royal family.[9]
Let the hunt be called so that the giraffe may be killed,
The giraffes conceal themselves in the shade of the rocks as they run away.
In the Chief's kgōrō they slept without having eaten,
The night was spent in cutting up the spoils, in cutting up the breasts of the cattle, of the eland and of the giant eland.
Do not choose your people but distribute the spoils amongst the commoners and the servants of the Chief also, for it is they who fight the Chief's battles:
The boasters are the ones who shrink from the fight,
The Chief's servants are always the ones who are killed.

[3] Ikaneng's own cattle-post.

[4] A small hill west of Gabane and on the south side of the road from Gabane to Kumokwane and Kolobeng.

[5] Ikaneng.

[6] Mokgosi's eldest son by Mma-Thoto (sixth house).

[7] Leader of the Maakatladi age-unit, see Appendix.

[8] See 2 above.

[9] Can only refer to Ikaneng, who is well known to have been a very tall man.

II. Rhinoceros of the Maratadiba![10]
Rhinoceros of the salt-lick, what shape are your horns?
When they began to curve they curved inwards,
Your horns grew close together without any space between them,
They took up most of the room on your face.
You knew yourself that your destiny was to kill a man because you had already wounded a member of the Kgwadibana;[11]
You seized him and tore his ribs apart,
His ribs hung in disorder, they remained exposed and were rotted by the blow-flies, for these and others of the tribe of flies are the creatures of nature.
Since he is the caretaker of the milk cows of Sebègo,[12]
Run fast keeper of the Kgwadibana cattle-post,
Run fast and announce the death of your people,
Say that the Rhinoceros has created havoc over there.
Rhinoceros of the curved horns, brother of Mokgōywe![13]
Rhinoceros of the upright horns, relative of Kobuane![14]
Saviour of the house of Mma-Thatō,[15] of the family of Mokalakane[16] and Letebele![17]
He came and took the burden off our shoulders.
When we were hard pressed and the entrances to the kgotlas of Gaobotse and Moeng had been closed he came to our assistance;
When the village Criers sounded the alarm far and wide the kgotla of Mpya was full of fighting men.
They called upon the people of the Madisakwane kgotla,[18] crying, "Save us, here we are overwhelmed," and he[19] being the Reliever of Burdens, went to their assistance,
For we were in the pot, we were cooked and the lid had been placed over us.
Someone called out to the Moeng kgotla, saying,
"Come and see, there is a man here, and the poles of the kgotla have

[10] Small water-course in the BaTlokwa Reserve, Gaberones.

[11] BaNgwaketsi cattle-post.

[12] Chief of the BaNgwaketsi after Makaba and before Gaseitsiwe I.

[13] Eldest son on Mokgosi's fourth house.

[14] Kobuane, son of Pooè-a-Mokgōywe by his fifth wife.

[15] Mokgosi's ninth wife (Lekgoane), from Moeng Kgōrō.

[16] Second son of Mokgosi's third house.

[17] Daughter of Seabele of the Nare Kgōrō. Mother of Moepi and Sekgèrè.

[18] Magōgwe, fourth son of Pooè-a-Marumō begat Nkwe-a-Magōgwe, who begat Monametsi, who begat Disèko, who begat Magosi, who begat Radikota the present Headman of the Madisakwane kgotla.

[19] Ikaneng.

fallen on him: he meant to start a fire but the poles fell on top of him."
The spear took him in the chest and again just below the breast-bone.
I know him, but his name escapes me for the moment.
I know him by the scar on his head, for a man carries his scars to the grave.
In appearance he is not unlike the son of Lekgaua; [20]
I, my friends, am not to be deceived.
The BaKgatla of Logapane [21] were there, also those of Ramodibedi; [22]
Kgari, the son of Macheng was present, also the son of Mangope.[23]
The son of Pooè got in amongst the spears, right in the thick of the fight;
We were telling him not to be rash, but to come back, son of Mokgosi, and wait until the flames turned to red-hot coals,
But he was impatient this scion of the house of Marumō, and said, "I will not burn, I will be safe for God will be at my side"—
He saw his father's village being burnt by enemies, being burnt by the sons of Sekgèkgèthè,[24] and he said, "The fire will destroy the one who lit it,
"The younger brother of Mongala-a-Mathwanyana [25] will perish; he will burn, his skin will shrivel up like a skin which is roasted on the fire.
"Bathoeng does not shoot, he is shaky since he was stunned by the voice of Ikaneng rallying his buffaloes.
"Shoot hard people of Maiō, people of Mongatana, the son of Maoka,
"Shoot hard and save the position.
"People are invading our homes and destroying the village we built.
"They are wrong, they will burn only one hut and we shall prevent them from burning the others.
"Ikaneng has spoken!"
The dust of the battle resembled a hail storm, Conqueror,
It was like drops of rain,
As for spears, they fell like rain!
"Pankga!" went the cow as it lashed out with its hind foot;
The red-and-white cow kicked and became restless;
The white cow kicked the milker and broke the pail between his knees;

[20] One of the BaNgwaketsi, father of Tsimè.
[21] Manaana (Gopane).
[22] The site of a former BaKgatla settlement at or near Tswenyane, some 10 miles north-east of Dinokana (Transvaal).
[23] Kontle.
[24] BaNgwaketsi.
[25] Son of Makaba I (?).

The milk became full of manure dust, Conqueror, son of Pooè and Mokgōywe!
When he got up he was breathing hard and wiping the tears from his eyes.
He said, "I might have pretended when the fight began, I might have pretended that I was lame and said that I limped because of a sore leg, having yesterday fallen into an ant hole;
"You have overcome us, people whom we do not know and whom we thought not to be worthy of notice—you milked the family of Pooè and Kgamelō-a-Mmitlwa [26] in the short scrub bush."
Let us see now how you aim, people of Mongala-a-Mathwanyana;
You fumbled when you aimed at the red-and-white cow, you aimed at the wrong side of it, the side on which it is not used to being milked;
You made a mistake and it will kick you;
You did not properly fasten the legs of the black cow with the white back.
I am not despising you, sons of Sekgèkgèthè; [27]
You had drunk beer made from morètlwa berries and were full;
You were still drinking up the last drops and had lost your powers of reasoning;
You threw yourselves on to the buffalo's horns—it caught you and tore your ribs apart,
It tossed you as you were about to cross the Taung River.

III. Venerable One of the Maatswakgosi [28] I am not caught,
"Tii" said the stone on striking ground,
"I have embedded myself in the earth and am become as the earth's heart."
Kontle said, "I begat twins, I begat the MoNgwaketsi and the MoKgatla, also Kgari, the son of Macheng."
Kontle, produce something more and let us see it!
Whatever it is, it will come and devour them and cause the people to vanish.
It will eat these twins of Kontle's.
Cry, and then stop crying, mother of Bathoeng,
We have not yet seen your children,
We hear they have gone Southwards;
Had we seen them we should have killed them.
River with the broad channel, I am full,
In the Taung River was wrecked the ship of Kontle and Bathoeng.

[26] The Ba-ga-Malete.
[27] The BaNgwaketsi.
[28] Ikaneng (now grey-headed), leader of the Maatswakgosi age-unit.

Part II.—HISTORICAL ACCOUNT.

HISTORY OF THE BA-GA-MALETE OF RAMOUTSA.

Tradition tells us that Phatle's Matebele lived at Tlhōgō-a-Tlou, in the North, and that on Phatle's death his people, led by his son Malete, crossed the Lepenole River and settled on the banks of the Nkompe River near the hills Mogodumō, Matome, and Mmabolope. From that place they removed to Mokateng * or Mosèsèle (also called Moletlane), and yet a third move brought them to Lekgopung, where there is a mountain, the top of which is always hidden by clouds—on one side of the mountain they dug for iron, while from the other they obtained red ochre. There was a kloof, or gorge, in the mountain in which rose a stream which, lower down, formed a deep pool from which they drew their water.

During their stay at Lekgopung several sections of the tribe hived off: the Ba-ga-Mokopana were the first to go, followed by the Ba-ga-Laka, the Mmauna, the Ba-ga-Letwaba, and the boo-Seleka.

From Lekgopung Malete and his people went to Fhafung, where there is a hill called Mogosane in which rises the river Ngorètèle, and from Fhafung they went to Tswane (now Pretoria).

While they were at Tswane the tribe suffered severely from famine. Now it was the custom for one of the Kgōrōs † to give the Chief a black ox or cow (not a bull) and ask him to make rain: the Kgōrōs had to decide among themselves which one of them was to have the honour of presenting the animal, and when it had been given the Chief would assemble the tribe to see it: he then invited the Rainmaker to inspect it, after which the Rainmaker would go out to gather his herbs, placing some on the boundaries to ward off lightning, hail, and whirlwinds, and keeping others for the ceremony of the sprinkling of the black ox or cow. On the return of the Rainmaker all girls of initiation age gathered together and accompanied him to the river. They carried small clay pots which they filled at the river, where also they gathered branches of the Modubu or Mositsane tree. To the accompaniment of song and dance the party returned to the village, where the Rainmaker poured the water from each small pot into the big rain pot which was embedded in the ground in a special enclosure behind the Chief's hut; he then placed his herbs into the water and after stirring took out some of the resulting "medicine" and went to the kgotla where he sprinkled it over the animal, the children all this time dancing and waving their branches at the Chief and asking him where the

* The place of red earth.

† A ward or section of the tribe, see Appendix A.

rain was. After this the beast was released and sent out to graze in the belief that wherever it went the earth would be prepared for the reception of rain and the production of its fruits.* Indeed, the drought was broken by such copious rains that the locality was named "Tswane"—the place of the black cow.

More sections of the tribe broke away at this time, viz. the Bapo, the Ba-ga-Ntshwe or Ba-Gwadubu (who now live near the BaKgatla-ba-ga-Mosétlha, in the Transvaal), the Ba-ga-Tlhako (BaTlōkwa now living in the Transvaal near the Ba-ga-Kolontwane), and the Ba-ga-Moepshwe, who are to-day represented by two groups, viz. the Ba-ga-Kōnyana, under Headman Letshuhile, and the boo-Motswaana, under Headman Sekhutlo, both living at Serowe in the Bamangwato Reserve.

Moepshwe's departure was due to a quarrel with his elder brother over a ram. The elder brother had instructed his herds not to lend the ram to anybody, but when Moepshwe's ewes lambed, the lambs so resembled his elder brother's ram that the matter was reported to him, whereupon he caused Moepshwe's sheep to be seized and brought to him: he then claimed that the lambs were undoubtedly the progeny of his ram and as such belonged to him. Moepshwe was so distressed that he decided to go away. When he and his followers took their departure they left a lamb tied to the branch of an olive tree (Motlhoare), hence their being known as the Ba-ga-Kōnyana-a-Motlhoare.

The Ba-ga-Malete remained at Tswane for some time and later migrated southwards towards Majwaneng. They settled at Nape Hill for a while, then went to Mafhika-a-Tlhoe, from there to the Magaliesburg Mountains (a ga Mogale), then to Kgetleng (Zwartruggens), then to Mmatshidi, east of Mangope; † they crossed the Madikwe (Marico) River at Sekhutlong and the Mainelwe (Klein Marico) south of where the railway line is now, and finally settled at Rabogadi.

It is uncertain when or where Malete died, but these moves were carried out over a considerable period of time, as Maphalaole was chief when the tribe settled at Rabogadi.

Maphalaole and his predecessors had all belonged to that section of the tribe which we call "Ba-ntlha-ea-godimo" ‡ (kwa go Mpya), and the

* "E kgaa lefhatse."

† Mangope Siding, about 4 miles east of Groot Marico Station on the Mafeking-Zeerust–Johannesburg railway line.

‡ We understand that whenever a people move from one place to another, whether from choice or force of circumstances, the presence of an adequate supply of water is always a condition precedent to the establishment of the new town or village, and this condition being fulfilled it was customary for the Chief and the "Ba-Kgosing" to settle "up-stream," the rest of the tribe building next to them but lower down: this explains why the former were called "Ba-ntlha-ea-godimo" (they of the upper part of the village) and the latter "Ba-ntlha-ea-tlase" (those of the lower part).

story of how the Chief and his immediate followers, the "Ba-Kgosing," lost this status is as follows:—

Maphalaole had a brother, Maoke; Maoke had three wives and each wife had a male child. The names of the boys were Nare, Masokwane, and Mongatane. The mothers of Nare and Mongatane were sisters, and these boys were born about the same time; Nare's mother died in childbirth and Mma-Mongatane reared Nare and her child together. When the three boys grew up they began to grumble because the "Ba-ntlha-ea-godimo" had the pick of the lands and their crops were invariably better and larger than those of the "Ba-ntlha-ea-tlase." They decided, therefore, to ask the chief to let them go and look for food amongst their neighbours; suspecting nothing, Maphalaole consented, and they went over the hills and established themselves at Mmasamane * or Motlhaka-oa-Madisa (at the junction of the Groot and Klein Marico rivers). The site on which their village was built was called Sekatemosima.†

They were soon followed by all the "Ba-ntlha-ea-tlase," only the Chief and the "Ba-ntlha-ea-godimo," or "Ba-Kgosing," remaining at Rabogadi.

Later on, Nare asked Mongatane to tell him in what manner he could show his gratitude for the way his aunt had brought him up. Mongatane said, "Give me your cattle-post (Moraka-oa-Masweu)," but Nare demurred, saying that the cattle-post alone would not be enough, and he then gave Mongatane the chieftainship as well as the cattle-post. He called the people together and built a kgotla for Mongatane, sending all cases to him to settle. Mongatane acknowledged this gesture by informing Nare of the result of each case tried by him.

One day raiders brought Nare and Mongatane some cattle which they had captured, and the people gathered together at the kgotla to witness their distribution. The meeting was attended by some of the "Ba-Kgosing" who expected that the division would be according to traditional procedure, that is to say that the chief (Maphalaole) or his representative would enter the kraal and choose what cattle he wanted, the maternal uncles of the raiders would then take their pick, after them the fathers of the raiders, and lastly the raiders themselves who would share equally in the cattle left. Mongatane, however, went into the kraal first and took his pick, he then beckoned to Nare to go in and help himself; Nare returned the compliment by sending Mongatane to choose a second lot, then a third lot, which he said were for their brother Masokwane. The uncles of the raiders (ba-ja-ditlhōgō) were then sent in, followed by the fathers, and after them the raiders. Maphalaole got nothing, and his people went home with full proof that the "Ba-ntlha-ea-tlase" had usurped the chieftain-

* The place of squirrel holes.

† The place of "meerkat" holes.

ship, and for some unexplained reason Maphalaole and the Ba-Kgosing, instead of asserting their rights according to the manner of the day, actually left Rabogadi and came and settled under Mongatane.

We have no knowledge of the doings of the tribe during the time Maiō and Kgomo were chief, but we know that during Mokgwe's time the tribe moved from Motlhaka-oa-Madisa to the valley of the Taung River, between Ramoutsa and Mogobane, and settled along the string of pans or vleis called Marètè, Seoposengwe, Mamaering, Matlapekwè, Setobe, Makanangwane, Ralenyana, and Mogobane,* where they carried on an extensive manufacture of iron implements and ornaments; the traces of their occupation, in the shape of furnaces and slag-heaps, hut foundations, grindstones, pottery, and graves, being visible to this day; † that while here the tribe was greatly reduced in numbers by a sickness called "botlhoko oa tlhōgō" (malarial fever), and that Mokgwe took the survivors back to Lotlhakane in the Transvaal. To-day the Ba-ga-Matlhaku, under Chief Solomon, occupy the site of the old Ba-ga-Malete settlement at Lotlhakane.

Mokgwe was succeeded by Marumō, and Marumō by Pooè-a-Marumō; these three chiefs died at Lotlhakane. The next chief was Mokgōywe, the second son of Pooè-a-Marumō.

Mokgōywe-a-Pooè.

Pooè's first son, Menwe, predeceased his father, but not before he was himself old enough to be a father: his child, by a junior wife, was Mogotsi. Now when Menwe died, Mokgōywe sent his eldest son Pooè-a-Mokgōywe (later Pooè II) into Menwe's hut "to raise seed unto him," according to custom, and a son named Boikanyo was born.

About this time we were attacked by the BaNgwaketsi who were living at Tloe (Linokana) under their chief Mathwanyana: they had secured the assistance of the BaKgatla of Manaana who were then at Ramodibedi, 10 miles north-east of Linokana, under chief Kontle, and crossed the Madikwe River, which was rising, at night. They slept in the Loduba bushes on the river bank and attacked us at dawn, but we overpowered them and forced them to retreat across the river now in full flood. Many BaNgwaketsi and BaKgatla were stabbed in the water and many more were drowned.

Mokgōywe initiated the Mafiri age-unit, and the youths were sent to

* About A.D. 1735. The village of Kubunakana was round the motlhatsa tree at what is now Manyana, in the BaNgwaketsi Reserve. This Motlhatsa tree is still flourishing and has, cut in its trunk, the initials R. M. (thought to be the initials of Robert Moffat, who passed this way and *via* Kolobeng on his way to visit Moselekatse in 1854).

† The Government has recently placed specially constructed metal coverings over the better-preserved furnaces.

herd cattle under the supervision of one grown-up man, Peba-a-Moètlhwa. In the heat of the day, while they were resting in the shade, they saw a party of BaKgatla from Manaana descending upon their cattle. All the youths, excepting one—Phōkō-a-Boiyane, of the Moeng Kgōrō—ran home. Peba and Phōkō set off in pursuit of the raiders, Peba killing one of them and Phōkō two (one with his spear and the other with a well-aimed stone). When our reinforcements came up, Mmolotsi said to Ra-Mathamèlō, "Seize that boy Phōkō and take him home, he is too young for this sort of thing and will be killed." Ra-Mathamèlō took Phōkō by the hand and led him away, but on the way Phōkō broke loose and ran back to the fight. The raiders were beaten off and the cattle rescued. Some of the party wanted to take them to the Chief, but others said that as they belonged to the Moeng Kgōrō they should be taken there—after some argument, Phōkō took them home.*

On another occasion, while the BaTlōkwa were at Pilwe, under Molefe, the son of Bogatsu, they sent their cattle to cattle-posts at Kolontwane. Kgori, the Chief's son, did not get on very well with his father, and while at the cattle-posts he led a raid on the Ba-ga-Malete cattle which were at Mothèoganeng, whither they had been sent for grazing. Kgori and his men found that the cattle were well guarded, nevertheless they attacked at dawn and while the fight was in progress a Molete woman ran home with the news, with the result that Mokgōywe dispatched a man with orders that the regiment was to make a strategic retreat—this they accomplished by pretending to run away. Reinforcements arrived and the BaTlōkwa were routed. Kgori fled, but his younger brother Mokanō and a handful of seasoned fighters held their ground, and as they fell, one after another, Mokanō saw that his position was hopeless, so he threw himself to the ground and his remaining men lay on top of him, but the Ba-ga-Malete pulled them off and made Mokanō prisoner. During the rejoicings which followed, one of our men, named Ratibe, stabbed Mokanō between the shoulder blades, killing him on the spot. The Ba-ga-Malete were very grieved at this, for a chief is not killed but taken captive and led to the chief. When Mokgōywe was told of Mokanō's death he was very angry and went into his hut to mourn for him. Ratibe was punished by being deprived of all his cattle, and Mokgōywe cursed him, saying he would henceforth make handles for women's hoes.

Mokgōywe's sons were Pooè-a-Mokgōywe, Pooènyane, and Mmolotsi of the first house, and Modingwane of the second house. On attaining manhood, Pooè and Modingwane, who belonged to the same age-unit (mophato), made a raid on a neighbouring tribe, the Ba-ga-Siko (Bakwena who venerate the Snake), without their father's knowledge. There had

* Praises of Phōkō-a-Boiyane, p. 3.

been tension between us and the Ba-ga-Siko because their herds made a point of swearing at and taunting our youths whenever they met, while herding the cattle in the veld; Phala-a-Mosidi and Letlharapa had reported this to Mokgōywe and begged him to let us fight the Ba-ga-Siko. The evening of the day of the raid, at the hour at which the cattle come home, found Modingwane concealed at the foot of a camel-thorn tree, suffering from a spear wound in the eye. The remainder of the regiment, taking with them the cattle they had captured, had crossed the Madikwe River, which was in flood, leaving Modingwane behind. Although wounded, Modingwane caught a spear thrown at him, broke the shaft, and hurling the thus shortened weapon, like a knob-kerrie, struck one of the Ba-ga-Siko pursuers, named Sehularwane, in the chest and killed him. While his friends were standing round the dying man, Modingwane threw himself into the river and although spears were thrown at him he reached the opposite bank safely. Meanwhile, when his regiment reached home, they reported that Modingwane had been killed, and his father, Mokgōywe, sat in the hut in the kgotla reserved for visitors and messengers and mourned for him. About the time when the period of mourning was over, a woman collecting fire-wood on the outskirts of the village saw a red-and-white ox-hide shield, and was running away when Modingwane called to her, asking her what she was running away from. She replied that the sight of the shield had frightened her, and she went on home and told her husband who, in turn, quickly spread the news in the village. The men immediately took up their spears and went to look for Modingwane, whom they found hiding in a Morukudu tree; they helped him down and, unnoticed, took him into the village. When he had recovered from his wound, Modingwane went to the kgotla where his relatives, old men in the tribe, said to Mokgōywe, "The children have become rich, the plain is filled with cattle; let us go and seize the cattle which they left." Mokgōywe gave permission, and all the regiments set off, but later on Pooè sent messages to his father that the fight was hard and they were tired, to which Mokgōywe answered that on a previous occasion the young men had won without the assistance of their elders; when the fight drew nearer the position occupied by Mokgōywe, the Chief was killed.*

Chief Pooè-a-Mokgōywe (Pooè II).

Mokgōywe was succeeded by Pooè-a-Mokgōywe, who, during the time he was mourning for his father, twice sent a regiment to warn the Ba-ga-Siko, by shouting and other noises, that he was determined to avenge his father's death.

* Praises of Chief Mokgōywe, p. 3.

One day one of the Ba-ga-Malete learned that the Ba-ga-Siko were having a "lecholō," or game hunt, on the following day. This man brought the news to Pooè late at night and told the Chief that all the neighbouring villages such as Moswana's (Bahurutse-ba-Siko) and Mmepe (another section of Ba-ga-Siko) were taking part in the hunt. Pooè then secretly ordered a "lecholō," and early next morning, when the Ba-ga-Siko went hunting, Pooè, wearing a lion skin, led his men towards their villages. Once outside his own village, Pooè ordered the dogs to be tied up and sent home; he then led his men on and presently made his dispositions for the attack, his orders being that the villages of the Ba-ga-Siko be destroyed. The Ba-ga-Siko soon saw the flames and hurried home, only to find their huts burnt to the ground and their women and cattle carried off: having nothing left to fight for, they surrendered and became incorporated in the Ba-ga-Malete tribe. Lesarwe, the wife of Mosoma, Chief of the Ba-ga-Siko, was captured in this raid and later became the mother of Pooè's son Moetshwe.

The descendants of the Ba-ga-Siko are to be found at Ramoutsa under Headman Molefe Botlhole, son of Dintwe Botlhole; in the Bakwena Reserve at Molepolole, under Headman Selema Morwarwele; at Kopong under Headman Rakhudunyane; at Gabane with Tau Manthe under Headman Moatlhodi Pule; in the Transvaal at Dinokana under Headman Molefe Tsana; and also at Mafeking. These people venerate the Snake to this day.

Some time after this victory over the Ba-ga-Siko, Pooè's wife Mma-Boikanyo, accompanied by her servants, left for a visit to her home at Lehurutse. In passing the village of Madibana, the Chief, Ruthwane, sent for them and took away MmaBoikanyō's kaross of Motsose (Reedbuck) skins, which were worn only by the wives of chiefs, and sent her home naked. Pooè was very angry at this and said he would hit Ruthwane between the eyes with a switch of Mokgalō that he might know who was the Chief.

One afternoon Pooè ordered a hunt for that night, and as usual on such occasions the dogs were kept at home. The party camped three miles from Madibana, spies were sent into the village, and when the inhabitants were in their first sleep Pooè ordered his men to advance. The main party was in the centre, with smaller parties on the flanks. In dead silence they reached the kgotla, and at the first sign of dawn the villagers heard the dreaded striking of assegais on shields, and voices calling out, "Let us join, let us join"—as they came out of their huts to see what the noise and commotion were about, they found all the exits closed and were easily killed. Nkwe-a-Magōgwe * fetched chief Ruthwane from his hut and

* Praises of Nkwe-a-Magōgwe, p. 12.

killed him out of hand. Prisoners were taken to Pooè's village and became incorporated in the tribe—those who escaped were scattered all over the place and attached themselves to other Bechuana tribes. The cattle captured on this occasion were divided into two herds and named Merepō and Merepyana.

Pooè had to deal with two rivals, each laying claim to the chieftainship. In the first place, his succession was disputed by Mogotsi (Menwe's natural son by a junior wife), but his claim failed and he took cattle and fled to Manaana the home of his mother, where he was suspected of intriguing and being responsible for a raid made by the BaKgatla on the Ba-ga-Malete cattle. The BaKgatla concealed themselves in the bed of the Madikwe River, at one of its numerous bends, but were seen by a Molete who promptly raised the alarm at home. When the Ba-ga-Malete reached the place they spread out and hemmed the BaKgatla in on three sides, the fourth side being blocked by a deep pool full of crocodiles. The Ba-ga-Malete closed in and forced the BaKgatla into the water where many of them perished. One MoKgatla, named Selawi, the son of Mathōgōyane, had hidden himself in a tree, and as Marope, a noted Molete warrior, ran by this tree, Selawi stabbed him in the shoulder. The spear was bound with bark instead of sinew, and Marope said, "Who are you—is that how you insult me." Selawi gave his name, whereupon Marope told him to come down and get his spear. Selawi said, "You will not kill me?—according to custom the man who is found in a tree or on an ant-hill is not killed." Marope assured him that he would not be killed, so he descended, was given his spear, and went away. The Ba-ga-Malete picked out the BaKgatla Headmen—those who were wearing cloaks made from leopard or red-cat skins—and killed them.

On another occasion Marope went out to clear a land, and while doing so he heard the alarm being sounded, and a man calling out, "The cattle have gone, the cattle have gone." He left his work and set off homewards, but, meeting the Crier and ascertaining from him which way the cattle had been taken, he went after them, armed with his axe only. After following the spoor for some distance he saw the raiders ahead and set to work to improvise a shield: he cut a stick and twisted a piece of skin round it: he then made a detour, and thus got quite close to two of the raiders, who were surprised to see this inadequately armed man coming towards them. When he had approached quite close one of the raiders threw a spear at him—he warded off the blow and picked up the spear. The other raider then threw his spear at him and again the same thing happened. Marope then attacked them; he killed one of his opponents and took his shield and spears, and ran after the second raider, who had taken to his heels, caught up with him, and killed him also. He then

continued his pursuit of the main body which had the cattle, and when they looked back, although they recognised the shield he carried, they observed that the man carrying it was not one of their party. Marope then declared himself by reciting his praises,* and they fled, leaving him the cattle, which he then headed off and drove home. On the way back he met his comrades who were following up the cattle, which belonged to Pule, son of Letlole, Chief of Mokhibidu. The cattle were taken to Pooè, who sent them on to Pule at Mokhibidu the next day. Pule gave thanks by sending Pooè a present of 10 oxen. After Marope had been cleansed, one animal was killed and eaten in celebration of his feat.

After this, peace reigned for a long time, and Pooè sent to Manaana for Mogotsi to return. On his arrival Pooè gave him cattle, and they lived at peace with each other.

The second claimant to the chieftainship was Boikanyō, whom Pooè refused to recognise on the ground that Boikanyō's father, Menwe, had never been chief. Boikanyō thereupon went to Lehurutse to obtain assistance in his fight for the chieftainship, for he looked upon Pooè as an uncle and not a father.

Being eager to get rich quickly, Boikanyō and his friends went straight to the Ba-ga-Malete cattle-posts, where they knew that Pooè's sons were living: from there, one night, Boikanyō stole into Pooè's village—they saw the Chief distinctly, sitting near the fire, and one of them, Seyang Mmitlwa, thrust his spear at him: he aimed at the chief's heart, but the spear struck him in the upper part of the arm. They ran away to rejoin the rest of their party whom they had left concealed in a bend of the river, and on reaching the cattle-posts told the people that the Chief was dead, and that in accordance with custom all the cattle must be taken home "to mourn for their owner." This was, of course, simply a ruse to obtain possession of the cattle, but Mokgosi (Pooè's heir) refused to be taken in, declaring that he had seen his father alive on the previous day. Seeing that their plan was being frustrated, Boikanyō sent for Mokgōywe, Pooè's eldest son, and he was never seen again. Boikanyō then sent for Mmolotsi † (Pooè's second brother), and he, although knowing that he was going to his death, left his spears and shield behind and obeyed the summons—he also was killed. Boikanyō then sent for Mokgosi, but he refused to go unless his uncle and his brother were first produced. Having failed to get the better of Mokgosi, Boikanyō and his friends took what cattle they could and returned to Lehurutse. Mokgosi wanted to lay an ambush for Boikanyō, but the plot was discovered and he was urged to leave Boikanyō alone.

* Praises of Marope, p. 13.

† Praises of Mmolotsi, p. 6.

The Bahurutse now invited the BaNgwaketsi, the BaKgatla of Mosièlèlè (Ba-ga-Manaana), the BaRolong, the Ba-Kgotu of Adam Kok, the Ba-Tlhaping, and the Ba-Roa (who used bows and arrows) to come to Boikanyō's assistance. They had heard of a thing called a gun, which was in the possession of one "Moro," also called "Diphafhe" from the plumes he wore in his hat, who lived at Kuruman, and they enlisted his help. In due course Lotlhakane, Pooè's village, was attacked and totally destroyed. It is related how a piece of cloth was shot through the gun, how it set alight the thatch of one of the huts, the fire spread, and the whole village was burnt out. All the cattle, sheep, and goats were driven off by the victors—the destruction of Pooè's village being referred to thenceforth as "Ntwa ea Diphafha."

Sore at heart, Pooè now dismissed all his old counsellors, listening only to two men called Mhulatsi and Mokgalo, who told him that it was Pooènyane and Modingwane who were urging on Boikanyō in his efforts to gain the chieftainship and who were responsible for the destruction of the village. Pooè thereupon killed Pooènyane, and with encouragement from his senior wife, MmaMokgōywe, he directed an assault on Modingwane one evening as he was counting the sheep and goats in the kraal. Although stabbed in the thigh, Modingwane managed to jump over the bush enclosure and fled to his uncle, Dira. MmaMokgōywe then persuaded Pooè to send word to Dira's grandson, Tladi, to kill Modingwane, but Tladi sent him instead to Poane in the country of the Bahurutse. MmaMokgōywe, Mhulatsi, and Mokgalo were now all in favour of putting Mokgosi to death, but he was warned by his mother, Seribe, and fled.

Pooè's settlement now broke up because of the assassination of Pooènyane, and Pooè went to Poane, but finding that he was not welcome there he went to stay with Kgafhèla of the BaKgatla; this tribe refused to have him so he returned to the Madikwe River and there found Phōkō Boiyane, who had dug a "gōpō" (game pit) and collected something of a village around him. Pooè thought that his own people would surely befriend him, but he was mistaken, for they drove him away to Melorane, past Dibasechobe (Vleischfontein), and in the end he went to the Bamangwato country where he died. He is said to have been buried at Kalamare (Bokaa).

It is said that in the course of his wanderings Pooè found Mokgosi with Moloinyane on the Madikwe River at a place called Maphèpè, north of Maloloane and Sikoane, and that Mokgosi tried to dissuade him from going to the country of the Bamangwato. Pooè is said to have answered him in these words: "I know how quickly and accurately you throw the spear and how swift you are in the pursuit of the giraffe and the ostrich,

* Praises of Pooè-a-Mokgōywe, p. 8.

but I also know all about the wild animals and how at certain times of the year they are difficult to approach—even for a man of your skill: at such times I will grumble that you are starving me. If you had a 'gōpō' I would stay, but as it is, it is better that I should go." Before leaving, however, he took a spear and climbed a tree, from the top of which he made water—cutting the flow with a sideways swing of the spear he said this was the severing of the womb. He cursed Boikanyō and his relations so that they should never regain the chieftainship, and gave the spear * to Mokgosi as a talisman, telling him to gather the Ba-ga-Malete into a tribe once more, and to look after his youngest son Kobuane—"If Kobuane is fit, you must give him cattle and a black-and-white ('phacwa') shield, but do not hand over the village to him as that is yours," were Pooè's last words. He was accompanied to the Bamangwato country by MmaMorwa, the mother of Segolabeng.

Chief Mokgosi-a-Pooè (Mokgosi I).

After Pooè's departure, Mokgosi went to the Bakwena who were living at Sokoane under Motswasele, the father of Sechele. Mokgosi had already been initiated and was then about twenty years of age. This was after the birth of Sechele (1810).

Mokgosi found the BaKwena and the BaNgwaketsi fighting over cattle: he joined in one of the raids and acquired some BaNgwaketsi cattle. He stayed on with Motswasele, and after a time again fought against the BaNgwaketsi, once more acquiring cattle. The BaKwena complained about this, saying that Mokgosi was amassing too many cattle while they got none, and Motswasele told him to leave as he had no desire to be killed on his account.

After leaving the BaKwena, Mokgosi went to the BaNgwaketsi whom he found at Monnyelatsela, west of Kanye. He settled amongst them, and in due course joined them in one of the periodical encounters with the BaKwena, this time adding some BaKwena cattle to his ever-increasing herds: this happened a second time, the BaNgwaketsi returning from the raid with empty hands, whereupon they complained to their chief, Makaba, and he told Mokgosi to leave his country.

Mokgosi went to Lehurutse, where he stayed with Headman Senosi Mekgwe: he was there when Sebitoane (Maphatana) came, and in the fight which took place at Mosèga, near Zeerust, in 1823, Diutluileng, Chief of the Bahurutse, was killed.

After Sebitoane came Moselekatse, but as the Ba-ga-Malete had never recovered their identity as a tribe they did not suffer at the hands of either.

From Lehurutse, Mokgosi went to Maruping on the Madikwe River—

* Now in the possession of Chief Seboko Mokgosi.

he was rich in cattle, and when his people saw this they came and attached themselves to him. From Maruping they moved to Rabogadi, where the tribe had lived in the days of Maphalaole—there they dug for iron.

Mokgosi's people had no cattle when first they settled at Rabogadi, but they built up a big trade in iron implements, supplying the BaRolong, the BaTlhaping, the BaNgwaketsi, and the Bahurutse with axes, spears, hoes, bracelets, etc., in return for goats and later for cattle. Four hoes purchased a cow, three an ox. The iron implements were loaded on to pack-oxen and taken to the tribes mentioned above, and when they had been disposed of the Ba-ga-Malete returned home with the goats or cattle they had acquired.

The smelting furnaces were situated outside the village of Rabogadi, as there was a supersitition that if they were within the village the iron would not mould properly (Go ilèlwa boyalwa le ting—bread—gore tshipi e sa tlhanye). Only old women, and girls under the age of puberty, were permitted to approach the furnaces.

Mokgosi now sent his cousin, Mogopudi,* to the Bamangwato to fetch Segolabeng, one of Pooè's children by one of his junior wives, named Mmamorwa, who had accompanied Pooè on his journey to the Bamangwato country. Mogopudi brought Segolabeng to Rabogadi, and the tribe then moved to Rakatana, between the Madikwe and Phalalwe Rivers. The site can be identified to this day by an olive tree known as Rakatana's Motlhoare.

It was at this time that Sebègō, Chief of the BaNgwaketsi, was driven out by his own people and came to us (about 1843). He had nothing—not even an ox. There was no fighting at this period, either at Rabogadi or at Rakatana, but the tribe moved to Lodubeng, where they were to come into contact for the first time with the Boers, who subsequently worried them without cessation, wanting the people to work as servants, farm hands, herds, etc. Sechele of the BaKwena was at Chonuane, but in 1845 he went to Kolobeng with Dr. Livingstone, and after his fight with the Boers at Dimawè in 1852 he removed to Dithèyane, near Molepolole, and invited Mokgosi and others to join him there.

We were now rich in cattle and accepted Sechele's invitation. We crossed the Notwani River at Ramoutsa, while our cattle travelled via Sengoma, a small hill south of the present village of Ramoutsa—we joined up with the cattle at Potsane, some twelve miles from Ramoutsa, and travelled on to GaThamaga. The time of the year was about October, "Go ise go longwe," † when we left Rakatana. In January, "re lometse," ‡ we were still at GaThamaga, and as we had left our crops growing at

* Son of Mokgosi's uncle, Pooènyane.

† Before the tasting of the first fruits of the season.

‡ Having tasted the first fruits of the season.

Rakatana we went back to reap because the season was too far advanced for us to prepare lands and plough at GaThamaga.

While we were gathering the crop (by stealth) the Boers killed one of our people named Mpokane (the elder brother of Nkile, a member of the well-known family to which Kealeboga Moahi belongs). On the day of Mpokane's death, the Boers captured Sekate—they kept him prisoner for a long time, but eventually he escaped and rejoined us at Dithèyane. The Boers had made him lead their oxen, and his buttocks bore the marks of their horns.*

The corn was conveyed from Rakatana to GaThamaga on pack-oxen.

From GaThamaga we proceeded to Dithèyane, and on the way met the BaKgatla of Manaana under Mosièlèlè, and the Bahurutse of Moilwe, at the GaKgatla River: Moilwe said the country was unattractive and returned to Pooè (the small hill in front of the Mission Station at Dinokana), while Mokgosi and Mosièlèlè went on to Dithèyane where they found Sechele.

Fhologang Pèba states that at the time of the removal of the tribe to Dithèyane, rain was far more plentiful than it is nowadays: there were periodical visitations of brown locusts (Segongwane), but the red-wing locust (Molome) was unknown. When the swarms came from the south, we caught and ate from the first arrivals only, says he: we used ashes as a substitute for salt, to keep away sickness. The country was swarming with lions, and travellers always stopped about an hour before sunset to gather wood and allow themselves time to build platforms in the trees for the women and children to sleep on—the men remained on the ground, keeping fires burning all night.

When we arrived at Dithèyane we established our cattle-posts at Letsōaneng: Sechele and his brother Raditsèbè (who married Nthèkè, Mokgosi's daughter by MmaPooè (or Moètsenyana) and later the mother of Motswakhumo of Ntswe-le-Tau) warned Mokgosi that the country was overrun by lions, but Mokgosi answered that his cattle were not afraid of lions. The Ba-ga-Malete killed many lions with their spears and with muzzle-loading guns which they obtained by barter from European travelling traders (hawkers) at Dithèyane. The price of a double-barrel gun was 8 or 9 head of cattle, and for a single-barrel gun 4 or 5 head.

The Ba-ga-Malete stayed at Dithèyane for ten years (until 1863): in the ninth year of their stay Sechele, feeling himself safe from the Boers, called upon the Ba-ga-Malete and the BaKgatla to pay tribute. Mokgosi and Mosièlèlè refused to pay anything to a Mochuana, saying, "We will

* Information given by Fhologang Pèba, who states that he was born at Rabogadi and was herding goats when Mokgosi sent Mogopudi to fetch Segolabeng from the Bamangwato country (about 1843); his age-unit, the Mayapōō, was formed in 1857 (approx.) at Dithèyane, and his age being then about nineteen he is now just about 100 years old.

pay to him who will collect tribute from all the tribes." Fhologang Pèba says he remembers hearing Mokgosi say to Sechele, who was poor in cattle, after Sechele had threatened not to let us go unless we paid tribute, "These cattle of ours come from the Madikwe River and will leave by this kloof by daylight." Mokgosi felt he was strong enough to stand up to the renowned Sechele and even waved his spear and shield in Sechele's face (a tlala ka thèbè—e nala). My shield, says Fhologang, was a brown one, speckled with white (Thamaga).

Mokgosi did not act precipitatedly, but meetings were held daily and eventually he came to an understanding with Mosièlèlè, whereby both agreed that they would leave on the same day: after ten years at Dithèyane we left for Mankgodi and the BaKgatla went to Moshupa.

We were at Mankgodi for twelve years (1863–1875), during which time Sechele sent Pule to call upon Mokgosi to pay tribute. Mokgosi said, "If Sechele speaks thus because we are living on his land, let him come and collect tribute from me. I venerate the buffalo and I shall pay tribute to no man except to him who collects it from one end of the country to the other."

While we were at Mankgodi, Mokgosi sent word to Moilwe of the Bahurutse to keep an eye on our cattle-posts at Mogofe or Moshaneng (Witkleigat), but Moilwe replied that our old customs were passing away and that we should get a missionary. Mokgosi sent back saying, "You are near the missionaries, send me one." Thus in 1865 the Reverend Christopher Schulenberg of the Hermannsburg Missionary Society (German), who had been at Shoshong, came to us from Dinokana and settled at Mankgodi where he built a church.

In 1875 we left Mankgodi because of Sechele's repeated demands that we should pay him tribute: we moved to Ramoutsa, but some of our people remained at Mankgodi under Masèga, and later Thobèga, and they are there to this day, recognising the chief of the BaKwena as their Chief.

Mokgosi was now very old and handed over to Ikaneng the duties of attending to the affairs of the tribe, but further trouble lay ahead, for in 1881 Gaseitsiwe, Chief of the BaNgwaketsi, told Mokgosi to return to the Transvaal as he was occupying BaNgwaketsi territory. Mokgosi refused to go, saying that he was in the country of his ancestors and that Gaseitsiwe had never known such names as Ramoutsa and Magopane (Ramontso-a-Kgōtlhō)—the small hill on the west side of Ramoutsa village; Mopipi-a-Monoge and Thutlwa-a-Molaolwa, son of Motala-a-Marumō, who dug for white iron in the quarries at Ditshiping, which is in the Transvaal, and for black iron at Magopane; these are all Ba-ga-Malete names.

There were rumours that the BaNgwaketsi were about to attack the

BaRolong, but, later, travellers told us that the attack was coming towards us. Mokgosi sent the Maakakgang age-unit to herd our cattle and protect the cattle-posts, while the older men of the Maatswakgosi and Mayapōō age-units were ordered to sleep outside the village every night. As time passed and nothing happened, apprehension died down, and most of the men were withdrawn from their positions, only certain members of the royal line, *i.e.* Ikaneng, Porogwe, Ntshwene, Modingwane, and a few others remaining on guard. The Chief received warning of the attack two days before the enemy reached the outskirts of the village; the Maakakgang were ordered to stay in the village—they slept in, and at dawn next day the members of the royal family who had stayed on guard saw the enemy approaching. Modingwane, Headman Lokote Motladiile's father, gave the alarm, calling out, "Ana, manong a tla ja seng" (What a feast the vultures will have!—get up, here are the BaKgalagadi!). To the tune of the wind whistling in the barrels of our guns we heard the tramp of many feet, and Ntshwene asked, "Where are these people of the muzzle-loading guns?" Modingwane fired the first shot as the invaders, wearing blood-red turbans (which they later on concealed), reached Ntsuape's village and set it alight. The BaNgwaketsi army was composed of a number of divisions, and the bulk of these, under the leadership of Bathoeng, tried to take us in the rear by passing south of the village, then turning east and heading for the villages of Gaobotse, Shuping, the Ba-ga-Siko, and Morokotogadi (Motsome), which lay just across the Notwani River. Bathoeng's regiment, the Maisantwa, took up a position opposite Mokgosi's kgotla with the object of capturing the Chief, but no sooner had the Ba-ga-Malete heard the report of the first shot than they rushed out of their huts and heavy fighting took place in which over 80 BaNgwaketsi were killed. The missionary, Schulenburg, and the blacksmith, Williams, counted the dead. Bathoeng's regiment and those east of him bore the brunt of our counter-attack and the whole of the BaNgwaketsi force was driven back. Bathoeng, who had left his men, in order to encourage those on his right wing, had to ride hard to avoid being cut off—he was mounted on a white horse, and one of his men's horses was shot under him. Bathoeng escaped by crossing the Notwani and riding south.

Before allowing us to pursue the enemy, Mokgosi called in his regiments to ascertain the number of casualties; we brought the guns of the BaNgwaketsi and laid them in piles in the kgotla. When Mokgosi saw all these guns he asked, in surprise, if these were the guns of the BaNgwaketsi, and we said they were, as we had ours. The Chief then sang the praises of the tribe, and at 7 a.m. he ordered pursuit of the enemy, but they had a big start. The wounded whom we overtook, and those who tried to hide in trees and bushes, were put to death. We ascertained

that the BaNgwaketsi had spent the night preceding the attack at the Mosètlha tree (since known as "Bathoeng's Mosètlha"), a few miles outside Ramoutsa Village, on the road to Mogobane. We picked up much ammunition and food there. A fighting man's food consisted of ground Motlhakolana berries mixed with roasted kaffir-corn (dipabi).

The whole BaNgwaketsi tribe had come on this expedition, and they were supported by the BaKgatla of Moshupa, under Pilane, and the Bahurutse of Manyana, under Kontle, son of Mangope.

We gave up the pursuit at Ntlhantlhe Hill, our losses amounting in all to 8 killed, while the BaNgwaketsi lost well over 100 men. Carbines,* muzzle-loaders, and spears were used in this fight.

One reason given for the BaNgwaketsi not renewing the attempt was that the Chief Montsioa of the BaRolong was at that time hard pressed by his own enemies and called on the BaNgwaketsi to go to his assistance, which they did—intending to deal with the Ba-ga-Malete at a later date, but in 1885 Sir Charles Warren declared a Protectorate over the country, and in December of that year Lieutenant A. J. Bethell of the Bechuanaland Border Police was instructed by the Administrator of British Bechuanaland to advise the Chief Gaseitsiwe to allow Mokgosi to take up his residence and to occupy within Gaseitsiwe's country a sufficient location for all Mokgosi's people, including those then in the Transvaal. Mokgosi was at the same time to be informed that he must either return and live entirely in the Transvaal, having no claim to British protection, or else live as a subject of Gaseitsiwe, bound to pay moderate and reasonable tribute and otherwise obey Gaseitsiwe in all things lawful.

As a result of these instructions, treaties were signed on the 25th and 26th December 1885 between Gaseitsiwe and Mokgosi, whereby the former engaged to rent to the latter and his successors as chief a piece of ground sufficient for the ordinary requirements of the tribe.

The conditions of tenure by Mokgosi and his successors were to be:

1. That they pay Gaseitsiwe an annual rent of 10 head of cattle.

2. That they recognise Gaseitsiwe as Paramount Chief, they retaining the right of jurisdiction in all matters immediately connected with their tribe the Ba-ga-Malete.

3. That they abide within such boundaries of the territory assigned to them as may be from time to time mutually arranged.

The treaty was signed on behalf of Mokgosi, who was a very old man, by Ikaneng, his immediate successor.

Chief Mokgosi died in 1886, and is popularly believed to have been buried in his cattle-kraal, according to custom. A grave certainly was

* Whitworth Patent, Westley Richards, hammer gun, C.575, produced to the writer.

dug in the kraal, but a black ox was slaughtered and its skin placed in the grave while the body of the chief was buried secretly in his court-yard.*

Chief Ikaneng (1886–1896).

The Blue Book C. 5070 contains a report and sketch,† made in April 1887, of the boundary between the countries of the Chiefs Sechele and Gaseitsiwe, which is interesting as showing that at that date Gaseitsiwe's territory was recognised as extending up to the Transvaal boundary.

Blue Book C. 5524 ‡ contains correspondence respecting a dispute between Ikaneng and Gaseitsiwe, "in whose country they, the Bamalete, were allowed to settle." Reference is made therein to a "Convention with Gaseitsiwe," to which Lieutenant Bethell obtained Ikaneng's signature on the 25th December 1885, but it is quite clear from Mr. J. S. Moffat's letter of the 12th July 1888, and from Lieutenant Bethell's statement quoted in Sir Sidney Shippard's covering dispatch,§ that it was under compulsion and contrary to his own convictions that Ikaneng signed the so-called "Convention," in terms of which he had to pay 10 head of cattle yearly in consideration of "the peaceful tenancy of a portion of Gaseitsiwe's country."

Ba-ga-Malete who were present at the time, say (in 1935) that Lieutenant Bethell, accompanied by one native policeman, came to the chief saying he had been sent by the Government to make peace between the Ba-ga-Malete and the BaNgwaketsi, and that each tribe was to pay 10 head of cattle, including one white cow. "We refused at first, because we had defeated the BaNgwaketsi in fair fight, and according to our custom it is for the aggressor to make a peace-offering of a white cow; Mokgosi, however, decided to "honour the Government's words" and the 10 head were handed over, although we were suspicious that Lieutenant Bethell would take them to Kanye in spite of his assurance that he would take them to Huhudi (Vryburg). There were no Bangwaketsi present on this occasion, and we have never paid tribute to them."

It might also be observed that although it appeared that Her Majesty's Government had always recognised Ikaneng as a petty chief living under Bathoeng,‖ yet the paramountcy of the latter over the former was keenly contested, in reference to Concessions, by divers Concessionaires,

* Fhologang Pèba says he carried the skin of the ox and placed it in the grave in the Chief's kraal.

† Pp. 83–84. Blue Book, C. 5070.

‡ Pp. 40–42. Blue Book, C. 5524.

§ 23rd July 1888.

‖ Gaseitsiwe's successor.

and was never admitted by Ikaneng nor has it even been asserted by Bathoeng.*

We have recorded that Chief Mokgosi died in the year 1886: he was succeeded by his son Ikaneng, but as had so often happened in the past Ikaneng's right to the chieftainship was to be hotly contested by Pule, the son of Kobuane, and to result in a serious dismemberment of the tribe. Ikaneng refused to relinquish the chieftainship, and in 1889 or 1890 Pule, accompanied by Mokgosi's sons Mokgōywe, Porogwe, and Mmolotsi, and other leading members of the tribe, left Ramoutsa for Sepitsi or Bohibidu (Crocodile Pools): dispute followed dispute until, in September 1891, Mr. W. H. Surmon, the Assistant Commissioner, held an inquiry at Ramoutsa which resulted in Ikaneng being declared the real chief of the Ba-ga-Malete.

In 1892 Pule and his brother Chukudu, together with Mokgosi's sons Mmolotsi and Diyèlwang, moved to Gabane; Mokgōywe went to Lekgopung (Haartebeestfontein) and Porogwe † went to Schoonlaagte, in the Transvaal.‡

From Gabane, Mmolotsi went in the direction of Molepolole—he died at the Manukwe River and his wife went to De Aar to fetch Pooè (Mmolotsi's elder brother of the second house), but he also died after reaching Manukwe, and the brothers' small following then moved into Molepolole.

Pule died at Gabane on the 24th November 1911, and was succeeded in the Headmanship by his brother Chukudu on the 4th December of that year.

Gabane is situated within the BaKwena Reserve and the people recognise

* Lieut.-Colonel Jules Ellenberger, C.M.G., I.S.O. (joined the Bechuanaland Protectorate Service in 1890; interpreter to the Concessions Commission, 1893; interpreter to Sir Sidney Shippard's Boundary Commission, 1894, etc., etc.—Resident Commissioner), who was intimately acquainted with the tribes of the Protectorate for thirty-seven years, and was known from one end of the country to the other as "RaMaeba," says that from 1890 Ikaneng was invariably dealt with by the Administration direct and not through the Chief of the BaNgwaketsi; that in September 1895, Sir Sidney Shippard, Resident Commissioner, dealt direct with Ikaneng in the matter of the latter "ceding jurisdiction over the Bamalete territory to Colonel Frank Rhodes, D.S.O., in his capacity as the representative of the British South Africa Company," and that Ikaneng's right to do so, in other words his "independence," was fully acknowledged by Her Majesty's Government when, a few days later, the High Commissioner affixed his signature to the Proclamation of the 18th October 1895, whereby the administration of the Bamalete territory was transferred to the British South Africa Company.

† Son of Mokgosi's brother Kedimotse.

‡ Extract from the Blue Book Report on Native Affairs (Transvaal), 1905, *Bamalete of Haartebeestfontein*: "These are a branch of the Bamalete from Ramoutsa who left that place about 15 years ago. Formerly they lived on the Marico River near where Rikkert's Dam is, and are now settled under the Petty Chief Mogōbye."

the chief of the BaKwena as their chief although they still call themselves Ba-ga-Malete.

After Chukudu's death the Headmanship went to Pule's sons, first Masokwane, then Kgosinoka, and lastly Moatlhodi, who was appointed on the 15th January 1935.

Before the departure of Pule and his supporters from Ramoutsa, Mokalake (the eldest son of Mokgosi's third house) left because of his wife's illness. He went first of all to Tswaane (Brakfontein), then to Nakapshwe (Abjaterskop); on the 7th August 1892 he informed the Assistant Commissioner at Gaberones that he had been told to leave the Transvaal and that he had settled at Modipe * with some ten men.

At the Concessions Commission which sat at Gaberones in May 1893, and at which Ikaneng was present, Messrs Grundlingh, de Beer, Marais, and Jacobz claimed that Ikaneng had granted them a certain Mineral Concession, dated the 5th January 1888, which gave them the right, in consideration for certain payments, to prospect for precious stones and minerals and to select mining areas. The Commissioners reported that in this case the Chief did not understand the terms of the Concession and did not consult his Headmen and people before granting it. The Secretary of State therefore decided that the Concession was not open to recognition: this involved a loss of £50 a year to the Chief, and with a view to allaying discontent and promoting friendly relations the British South Africa Company undertook to pay to the Chief a yearly solatium of £50, which is still paid to this day.

In January 1896 Sir (then Major) Hamilton Goold-Adams and Mr. W. H. Surmon left Gaberones to define the boundary between the BaNgwaketsi and the Ba-ga-Malete. Ikaneng sent Baitlutle, Fhologang, Mogane, and Ntlharapane to represent him. The Commission started its work at Phata-ea-Lefika and proceeded to Rakgopedi. Ikaneng claimed that the line should run from Rakgopedi to Phata-ea-Magoshwe and from there to Ntlhanthle Hill, but on reaching Ntlhantlhe the Commission looked in vain for Ba-ga-Malete cattle-posts and Major Goold-Adams said that although we had pursued the BaNgwaketsi as far as Ntlhantlhe, after the Ramoutsa fight, it was evident that we did not care for that part of the country since there was no beacon and BaNgwaketsi cattle were actually grazing to the east of Ntlhantlhe. Major Goold-Adams brought the boundary back to Kike where there was a deserted cattle-post of Kobue's. A beacon was erected on Kike Hill and from there the line was taken to Nōga Hill and thence to Marapō-a-Tshwene, but it was not

* The village founded by Mokalake is on the BaKgatla side of the Gaberones Block-BaKgatla Reserve boundary which here runs in a straight line from the beacon on Modipe Hill to that on Oodi Hill, ten miles from Gaberones.

until 1909 that the boundaries of the Bamalete Reserve were defined by Proclamation.*

Ikaneng died in 1896 and was succeeded by his son Mokgosi II.

Chief Mokgosi II (1896–1906).

In the year of Chief Mokgosi's accession we lost nearly all our cattle from Rinderpest.

In 1897 the boundary between the Protectorate and the South African Republic, from Sengoma to Sakutswane, was defined by a Commission consisting of Major Panzera, as President, and Messrs. Y. P. Snyman and F. J. Watermeyer, as Members.†

We took no part in the Anglo-Boer War other than to guard our eastern border. Commandant Cronje and others of the Boer Forces wanted to come into Ramoutsa to take the Chief, but Commandant Piet Swarts of Zeerust would not allow this.

The Chief and practically the whole of the tribe travelled to Crocodile Pools in 1906 to join the other Chiefs and tribes of the Southern Protectorate in greeting the High Commissioner, Lord Selborne. That was a memorable gathering for we all travelled by wagon and the meeting was very well attended by all the tribes.

On the 30th June 1906 Chief Mokgosi died after an illness of three days, and as his heir, Seboko, was too young to succeed to the chieftainship, the tribe elected Mokgosi's brother, Baitlutle, as Regent.

Acting Chief Baitlutle (1906–1917).

One of the first things which Baitlutle did was to build a new Kgotla and tribal office. These are in use to-day.

In 1908 Mr. Surveyor Ashton demarcated the boundary line from Nõga Hill to the south-western corner of the farm Crocodile Pools. The Ba-Ngwaketsi and the Ba-ga-Malete each paid a half-share of the cost, the total of which was £35.

In 1909 Seboko went to Tigerkloof Training Institution to be educated, and he remained there until the end of the year 1914.

1910. Baitlutle represented the tribe at the meeting held at Gaberones on the 23rd November, when His Royal Highness the Duke of Connaught met the Chiefs and tribes of the Southern Protectorate.

1912. In this year the Bamalete National School was built.

1913. Certain of our people who had been working in the Diamond Mines brought a brass band and drum from Kimberley for the purpose of earning money by playing at Ramoutsa and in neighbouring villages, but the effort did not meet with much success.

* Proclamation No. 28 of 1909, Appendix C.

† Award of the 25th March 1897, Appendix B.

Baitlutle again represented the tribe when the High Commissioner, Lord Gladstone, visited Gaberones on the 28th September.

1916. In November of this year, 50 Ba-ga-Malete under Adolf Mokgosi left for Cape Town to join the South African Native Labour Contingent for service Overseas.

Chief Seboko Mokgosi.

1917. On the 3rd of July, Baitlutle handed over the Chieftainship to Seboko. An age-unit had been sent out to obtain a leopard skin for the occasion—the leopard was killed by Lekota, at Sepetlo, and at the installation ceremony the young Chief's grand-uncle, Sebodu, placed the skin on his shoulders. The then Resident Commissioner (the late Sir Edward Garraway, K.C.M.G.) and the Magistrate of the district (the late Mr. Myles Williams) were present when Seboko was declared Chief of the Ba-ga-Malete.

1919. The Bechuanaland Protectorate Native Advisory Council was founded in this year, and the Chief, accompanied always by four or five leading members of the tribe, has attended all Sessions to date.

1925. The tribe was well represented at Gaberones on the occasion of the visit of His Royal Highness the Prince of Wales.

1926. The smallness of our Reserve,* the lack of grazing areas, and the problem of providing our young men with lands are matters which have been causing us great concern. Hemmed in on the north by the Gaberones Farms, on the south by the Lobatsi Farms, on the east by the Union of South Africa, and on the west by the BaNgwaketsi Reserve, the only avenues for expansion lie in purchasing farms in the north and south as these come on the market.

In 1921 we entered into negotiations with the owners of the farm "Crocodile Pools" on our northern boundary, and a group of farms comprising over 7000 morgen of ground on our southern boundary, but were unable to reach agreement with either. In 1925, however, we made an agreement to purchase 3000 morgen of the farm "Forest Hill" in the Gaberones Block, for the sum of £2500. Every man in the tribe was to contribute £5 towards the purchase price, on his return from work, but unfortunately all have not done so and we are still paying off the capital amount plus interest.

In 1926 we were offered, and purchased for £100, plus £34 transfer duty, 100 morgen of the farm "Aberlemno" on our southern border. The acquisition of this piece of ground placed the whole of Manyèlanong (Assvogel Kop) within our Reserve.

1932.—The High Commissioner approved of the purchase of the farm

* Area of the Bamalete Reserve, 178 square miles, or 53,970 morgen. Population, 1904, 4107; 1911, 4462; 1921, 4578; 1935, 6570. *Cf.* Appendix F.

"Atholholme," in the Gaberones Block, and adjoining "Forest Hill," for £1250, but as there was at that time the prospect of a failure of the crops, the Government advised us that the acquisition of more land should stand over until better times, and that we should devote the resources which we had contemplated applying to the purchase of this farm to the purchase of food, and it is as well that we did so, for we have never known a worse season than that of 1932–33.

1934.—In March the Chief and many of our people travelled to Gaberones to pay their respects to His Royal Highness Prince George (H.R.H. the Duke of Kent).

In July, Efogang, son of Headman Lokote Motladiile, completed his course of training at Tjōlōtjō, Southern Rhodesia, and was posted to the Bamalete Reserve as Agricultural Demonstrator.

1935.—For more reasons than one this has been a memorable year in our history.

We shall for many years remember the celebrations held in the Kgotla in honour of His Majesty the King's Silver Jubilee. The Chief had ordered the performance of tribal dances and war songs, *i.e.* Modikanō, Meèpèlane, Koma, Ditlhaka, Koi, Morupō, and there was much practising beforehand. On the day itself, the 6th May, the Kgotla was filled to capacity by a rejoicing tribe. The Chief was the recipient of His Majesty's Silver Jubilee Medal.

Another event has been the establishment, at Ramoutsa, of the Roman Catholic Mission, and we look forward confidently to the work of this Mission bringing light and benefit to the tribe.

Seboko Mokgosi
CHIEF.

As witness — Levi Moumakoa

Baitlutle Ikaneng. His x mark
Headman.

Lokote Motlaliile
Headman.

Isaac Mokgosi
Headman.

Ramoutsa,
31st December, 1935.

K. Ellenberger
RESIDENT MAGISTRATE.
31.12.35.

Part III.—APPENDICES.

APPENDIX A.

Short Survey of the Social Structure, Form of Government, and the Judicial System of the Ba-Ga-Malete.

The unit of the Tribe is the family; several families constitute a clan or lineage group (lekgotlana), the head of which (Mogolwane or Elder of the group as distinguished from "Mung wa Ntlo," the owner of a hut or head of family) is the senior male representative of the lineal ancestor; a number of clans form a village (Motse or Kgōrō) under a Headman (Kgosana), and the "father" of them all, the "Chief Justice" and "Head of all Departments," is the Chief.

The government of the Tribe is composed of regularly graded executive powers—the head of the family must keep his family in order, the Elder maintains peace and order over his group, the Headman is responsible for his village and the Chief for the whole Tribe. In this way, matters affecting the Tribe as a whole or any individual member of it pass through one or more of the stages indicated on their way to the Chief. The Chief does not rule alone, but with the assistance of his sons, if they are sufficiently old, his paternal uncles (borrangwanaagwe), his younger brothers (bomonnawe), and the heads of leading families who form, collectively, a body known as "Lekgotla la Kgosi" or the Chief's Council. Tribal affairs are discussed either in the Kgotla, which is the customary meeting-place of the Tribe, or at a Letsholō (meeting held outside the village when all those attending it come armed), or again, but very rarely, in the Chief's cattle-kraal (Phutègō ea Lesaka) when the proceedings are secret. The Chief usually introduces the subject and does not speak again until, having listened to the views of the people, he sums up and gives his decision. Great attention is paid to the utterances of the old men of the Tribe, though they may not belong to the higher classes, because they are "the repository of oral tradition." The Chief is not bound to follow the views or advice of the Tribe, as placed before him by the tribesmen or by those who represent them, but a wise Chief keeps in mind the proverb which says that a chief is chief by grace of his tribe (Kgosi ke kgosi ka morafe).

Domestic matters or family disputes (Dipuō tsa lolwapa) are dealt with "en famille" and rarely go further than the lineage kgotla—in other words, they are settled "out of Court"; should attempts to reach a settlement fail, however, the matter is taken to the Headman's Kgotla for trial (go sèka). If the issue is complicated and the Headman feels that the matter is beyond his powers to deal with he may remove it to the Chief's Kgotla; on the other hand, if he disposes of the case but the parties, or one of them, are not satisfied with his decision, an appeal lies to the Chief's Kgotla. It is the Chief's prerogative to deal with all cases involving serious bodily injury (Dinthō ke tsa Kgosi).

The Ba-ga-Malete Tribe is divided into seven main divisions or Kgōrōs,

one of which, the Chief's, has five sub-Kgōrōs, and all these Kgōrōs are again divided into, or made up of small kgotlas—the lineage kgotlas or Makgotlana, viz.:

TRIBAL DIVISIONS.

Division.	Name.	Head.	Totem.
1. KGŌRŌ.	MOKGWA or KGOSING (eo Marumō).	CHIEF SEBOKO MOKGOSI.	Nare.
Kgotlana (*a*)	ea Morepyana.	Nkwane Porogo.	Nare.
,, (*b*)	ea Moitsètō.	Phetwè Raletsebe.	Nare.
,, (*c*)	ea Madilotsana.	Sekgere Madimabe.	Nare.
,, (*d*)	ea Magadingwana	Headman Lokote Motladiile.	Nare.
,,	(1) ea Madibana.	Ntsètlhè Moswang.	Kolobe.
,, (*e*)	ea Mokate.	Kgwedi Masi.	Nare.
,, (*f*)	ea Madisakwane.	Headman Radikōta Magosi.	Nare.
,, (*g*)	eo Motala-a-Marumō.	Maribe Ntswene.	Nare.
,, (*h*)	eo Magadimō.	Phelelō Moseki.	Nare.
,, (*i*)	eo Rammalō.	Ratau Ntsontsi.	Nare.
,, (*j*)	eo Thibedi.	Oteng Tlhomèlang.	Nare.
,, (*k*)	ea Letsèkèla.	Headman Maletenyana Tsetse.	Misc.
,, (*l*)	boo Thamagana.	Maphèrèsukwane Moatlhodi.	Nare.
,, (*m*)	boo Matlanyane.	Seshabo Barèi.	Nare.
,, (*n*)	eo Madibana.	Moyadife Moyanaga.	Phofu.
,, (*o*)	ba-Ngwato.	Lebogang Nakedi.	Phuti.
,, (*p*)	Barokologadi.	Levi Motsome.	Kgabo.
,, (*q*)	Ba-ga-Mhatla.	Rabogosi Rantsana.	Kgomo.
,, (*r*)	Ba-Tshwapong.	Tshèlète Morafe.	Tlou.
SUB-KGŌRŌ.	MARUNGWANA. (goo Phelehu)	HEADMAN MOKATISI PHELEHU.	Nare.
Kgotlana (*a*)	Ba-Phinye.	Tsiè Kapōkō.	Thaga.
,,	(1) Mpya Bogōla.	Kgotla Matlhoko.	Phala.
,, (*b*)	ea Masweu.	Matebisi Magakwe.	Nare.
,, (*c*)	ea Shaodi.	Lesele Mhete.	Nare.
,, (*d*)	eo Mosidi.	Phuduhudu Phale.	Nare.
,, (*e*)	eo Mositsane.	Molèlèkwe Mosidi.	Nare.
SUB-KGŌRŌ.	MOENG (goo Moeng).	HEADMAN RAMONTSO MOTSHWAÈDI.	Nare.
Kgotlana (*a*)	eo Radiphèko.	Lesole Diphèko.	Nare.
,, (*b*)	eo Malefō.	Matome Seleka.	Phuti.
, (*c*)	boo Pere.	Ratshiping Mosèki.	Phuti.
,, (*d*)	eo Sebitsōnyane.	Tsome Moeng.	Phuti.
,, (*e*)	eo Ramasoko.	Kgale Molale.	Tshipi.
,, (*f*)	ea Maiphitlwane.	Shepherd Ratsièpè.	Kwena.
,, (*g*)	ea Ba-Kweneng.	Headman Rakola Ntsuape.	Kwena.
SUB-KGŌRŌ.	EO TAUANA. (Madibana)	HEADMAN TSÈBÈ KGARI.	Kolobe.
Kgotlana (*a*)	eo Keebine.	Molosi Mokwe.	Kwena.
SUB-KGŌRŌ.	BOO RRA SEBOGODI.	HEADMAN MOKWALARE MOILWA.	Thakadu.
Kgotlana (*a*)	eo rra Sanka.	Mmolokwane Moleofhi.	Kgabo.
,, (*b*)	eo Ruèlè.	Ruèlè Mothula.	Tlou.
,, (*c*)	eo RaMoloi.	Ntlotlang Olesitse.	Kwena.
,, (*d*)	eo RaNong.	Makgonye Nong.	Tshwene.
,, (*e*)	eo rra Makgoeng.	Lentebanye Makgoeng.	Kwena.
SUB-KGŌRŌ.	BA-GA-MMAMOKANO.	HEADMAN TIRO RAMOGOTSI.	Thakadu.
Kgotlana (*a*)	eo rra Morola.	Radikgōti Ikaneng.	Thakadu.

Division.	Name.	Head.	Totem.
2. KGŌRŌ.	MPYA OR NCA.	HEADMAN GEI KGETHENG.	Nare.
	(Nltheng ea godimo)		
Kgotlana (*a*)	eo Lekota.	Morōke Molebatsi.	Nare.
,, (*b*)	bo Tshètlha.	Tsètsè More.	Nare.
,, (*c*)	eo Morōka.	Edward Radipati.	Nare.
,, (*d*)	eo Dira.	Maletenyana Tsètsè.	Nare.
,, (*e*)	eo Diranyana.	Shuping Diranyana.	Nare.
,, (*f*)	boo Tshièlō.	Moremi Koie.	Nare.
,, (*g*)	eo Ramagama.	Kedikanetswe Basima.	Nare.
,, (*h*)	ea Madibana.	Kobuane Mogorosi.	Phofu.
,, (*i*)	ea Madibana.	Nokane Peloame.	Kolobe.
,, (*j*)	bo Moduka.	Mphafeng Moduke.	Tau.
,, (*k*)	boo rra Gaonèwè.	Morale Koeng.	Kwena.
,, (*l*)	boo Polo.	Nthepedi Molefe.	Kwena.
,, (*m*)	boo Phala.	Phale Kgetheng.	Noko.
,, (*n*)	eo RaMoswanti.	Peloewetse Moswanti.	Kwena.
3. KGŌRŌ.	NARE (goo Nare).	HEADMAN SEOKOPE MOÈPI.	Nare.
Kgotlana (*a*)	bo Malongwe.	Mpae Leboane.	Nare.
,, (*b*)	eo Tswabi.	Rantsobotho Matsidisi.	Nare.
,, (*c*)	eo Mongatane.	Toto Mongatane.	Nare.
,, (*d*)	eo Kubunakana.	Kubunakana Mosime.	Nare.
,,	(1) eo Kubunakana.	Morèkisane Pantlane.	Noko.
,,	(2) eo Moswanti (Ba-ga-Konyana).	Sepōta Moswanti.	Nare.
4. KGŌRŌ.	MANKGA.	HEADMAN KEALEBOGA MOAGI.	Nare.
Kgotlana (*a*)	eo Mogoga.	Dapiso Batsaleloang.	Nare.
,, (*b*)	eo Mongala.	Mongale Sitwane.	Nare.
,, (*c*)	eo Mongalanyana (boo rra Sitwane).	Belemō Seèlèlō.	Nare.
,, (*d*)	eo rra Tshukudu (Phuti ea ga Matlhaka).	Galeboe Morokane.	Phuti.
5. KGŌRŌ.	MENWE.	HEADMAN EPHRAIM KATSE.	Nare.
	(eo rra Dimpe).		
Kgotlana (*a*)	ea Mantso.	Gaobotse Ramonei.	Nare.
,, (*b*)	eo Motala-a-Marumō.	Ramotlhala Mosèki.	Nare.
,, (*c*)	eo Rantlabele (extinct).	Leyswai.	Tshwene.
,, (*d*)	eo Ruèlè.	Montisètsi Ramoeng.	Kwena.
,, (*e*)	ea Madibana.	Mabuse Tsonope.	Kolobe.
,, (*f*)	boo Pere.	Sefanye Orèkile.	Phuti.
,, (*g*)	eo Ramotlhagatsana.	,, ,,	Tau.
,, (*h*)	eo Ramaabong.	Legakwa Malate.	Kwena.
,, (*i*)	boo rra Mosèlè.	Berman Mosèlè.	Tlou.
6. KGŌRŌ.	GAOBOTSE.	HEADMAN MOKGALAGADI GAOBOTSE.	Nare.
Kgotlana (*a*)	ea Segwanyana.	Motlhabi Phagè.	Nare.
,, (*b*)	ea Madisakwane.	Magosi Disèkō.	Nare.
,, (*c*)	ea Madibana.	Mosèlè Kgoleng.	Kolobe.
,, (*d*)	eo Ramontlha.	Rantlole Ramolapong.	Kgabo.
,, (*e*)	bo Rammokwa.	Raditlhase Mokwe.	Noko.
7. KGŌRŌ.	NŌGA (Ba-ga-Siko).	HEADMAN MOLEFE BOTLHOLE.	Nōga.
Kgotlana (*a*)	eo Ralesètèdi.	Segaetso Tlōpōrwe.	Kgomo.
,, (*b*)	eo Rasetlhake.	Mototo Nkwè.	Nōga.

Equivalents of Totem names:

Kgabo = Ape.	Phofu = Eland.
Kgomo = Ox.	Phuti = Duiker.
Kolobe = Boar.	Tau = Lion.
Kwena = Crocodile.	Thaga = Finch.
Nare = Buffalo.	Thakadu = Ant-bear.
Nõga = Serpent.	Tlou = Elephant.
Noko = Porcupine.	Tshipi = Iron.
Phala = Impala.	Tshwene = Baboon.

APPENDIX B.

Thursday, 25th March 1897.

AWARD.

The Commission, having carefully considered the evidence brought before it, and minutely examined every point in the line, do make the following award:—

The line between the British Protectorate of Bechuanaland and the South African Republic passes from a beacon at Sinkgoma * (this beacon being at the foot of the hill Tsokwane, near the Notwane, in the poort between Tsokwane and the hill Kogwe) to a beacon on Tschukutswane † hill; from thence to a beacon on a knoll east of, and near to, a neck called Patamokala; and from thence to the beacon on Pitlaganyane.

These points being approximately in a straight line between Sinkgoma and Pitlaganyane.

Signed at Tschukutswane on Thursday the twenty-fifth of March 1897.

(Signed) F. W. PANZERA, Major,
British Commissioner, *President*.

(Signed) Y. P. SNYMAN,
Z. A. R. Commissioner
(Signed) F. J. WATERMEYER,
Government Land Surveyor
} *Members*.

After reading the Award to the Natives, the Commission took them to each point and showed them the beacons. (Signed) F. W. P.

APPENDIX C.

PROCLAMATION

BY

HIS EXCELLENCY THE HIGH COMMISSIONER.

(No. 28, 1909. Dated 3rd November 1909.)

PREAMBLE.

WHEREAS it is expedient to establish and define the boundary of a Native Reserve within the territory of the Bechuanaland Protectorate for the Bamalete Tribe:

* Sengoma. † Sakutswane.

Now, therefore, under and by virtue of the powers in me vested, I do hereby declare, proclaim and make known as follows:—

DEFINING BOUNDARY OF THE BAMALETE RESERVE.

1. The boundary of the Bamalete Native Reserve, of which tribe Baitlotle is the acting chief during the minority of Seboko, is as follows:—

Commencing from the south-eastern beacon of the farm Crocodile Pools, which is on the Transvaal boundary, the boundary runs along the southern boundary of the said farm to a beacon three-quarters of a mile south-east of the eastern entrance to the gorge Pata-ea-Lefika, being the southernmost point of the Bakwena Reserve; thence in a southerly direction to a beacon on Kika Hill; thence to a beacon on Noga Hill; thence along the northern boundary of the Lobatsi Block as defined in the Schedule to the High Commissioner's Proclamation No. 4 of 1905; thence along the Transvaal boundary to the aforesaid beacon of the farm Crocodile Pools.

COMMENCEMENT OF PROCLAMATION.

2. This Proclamation shall have force and take effect from the date of its publication in the *Gazette*.

APPENDIX D.

SOME ACCOUNT OF THE MANNER AND EXTENT TO WHICH THE TRIBE HAS BEEN AFFECTED BY CONTACT WITH EUROPEAN CIVILISATION.

The Ba-ga-Malete first came into contact with Europeans probably just a little over a hundred years ago: writing on the 11th May 1820,* the Rev. John Campbell mentions that the "Bammaleetee" were then living south-south-east of Kurreechane,† and we know that they left the Transvaal in 1853 because of what they refer to as the "persecution" of the Boers. It was in 1865, apparently, that a European first took up residence among them—this was the Missionary Christopher Schulenburg, of the Hermannsburg Lutheran Mission, who found the tribe at Mankgodi and later accompanied them to Ramoutsa where he continued to labour up to the time of his death on 24th May 1891. Mr. Schulenburg was succeeded by the Rev. G. Behrens, under whom the building of the Church was begun. The parish subscribed £1018, and the work was completed on 30th May 1898. Mr. Behrens died in 1900. The successors of these pioneers have striven manfully to continue the Mission's work, but they labour amongst an unresponsive people, and although the Mission now claims to have over 3000 members (of whom 1400 have been confirmed) this figure appears to be rather high and raises a doubt as to the value at which the native's comprehension of the term "Church Membership" is assessed. Only 13 per cent. of the tribe are literate and only 200 children out of a total of approximately 1000 of school-going age attend the National School at Ramoutsa, and the most common reason which parents give for their reluctance to send their children to school is that they fear they will be made Christians!

* *Travels in South Africa* (2nd journey): 1822, vol. i.

† Kaditshwene, then the principal "town" of the Bahurutse.

Although many of the old superstitions and ceremonials have fallen into desuetude, the Bogwèra and Boyale at any rate stand as monuments to the conservatism of these people: on the other hand, strict obedience to the first law of nature, which demands physical fitness and mental alertness, was relaxed to an unfortunate extent when inter-tribal raids and fighting ceased about the time when the Ba-ga-Malete came under the protection of Great Britain.

The tribal system began to totter at this time, when this tribe, like others in South Africa, lost its true sense of race-pride and dignity, reverence for the chieftainship, and respect for established institutions—in a word, its discipline.

During the succeeding years the people became less skilful in the chase and generally less energetic; arts and crafts were sadly neglected and have now been almost completely forgotten. The braying of skins and the making of picturesque skin garments and karosses, mining and iron smelting, and other forms of native art disappeared, due to the agencies and industries of modern European civilisation, which, creating as they do new wants and aspirations, made the collapse of the old tribal system inevitable.

In the old days the tribesman never kept all his cattle in one place, but distributed most of them among his relatives and friends to herd with theirs—he in the same way having some of theirs with his: the advantages were obvious when one remembers that the wealth of a tribe lies in its possession of cattle and that these were invariably the sole objective of raiding parties. The introduction of a money standard for the payment of taxes and the purchase of goods had a very potent effect on this system of cattle economy, for, where a man felt that he could safely entrust his cattle to another man's care, he became less trusting with money—in fact, money at once and in a very material sense promoted individualism at the expense of communal interdependence and solidarity.

The world-wide depression which followed the Great War, and later the economic distress resulting from drought, locust invasion, and foot-and-mouth disease, forced the male population to seek money in work beyond the borders of the Protectorate. The Ba-ga-Malete have never been partial to the idea of underground work in the gold mines of the Witwatersrand (which does not mean that none of them go there), but farm labour and the discovery of diamonds in the Lichtenburg district of the Transvaal attracted them in their hundreds, and it is estimated that 40 per cent. of the adult males of the tribe are now permanently absent at labour centres in the Union of South Africa. Many of these men take up with alien women whose children are never likely to become members of the tribe, and there is resentment that a man should thus squander his vitality where the tribe will reap no benefit. In many cases parents and families are left unprovided for and have to fend for themselves, while young women, instead of being respectably married, become the playthings of men who have become hardened by loose living at the diggings and in the towns.

It is not suggested that the morals of the Ba-ga-Malete have been on a higher plane than those of other tribes, but the cumulative effects of this side of the picture upon the tribal life are extremely serious.

It is to be hoped that the present state of chaos may prove to be but a passing phase in the evolution of the people, because much that

was undoubtedly good in the old system can be adapted to meet the changed and changing life of Southern Africa. In their own way, the Bantu have a very shrewd sense of the fitness of things: that they acclaim wise and progressive leadership and respond well to a just form of discipline is admirably demonstrated by the success of the Pathfinder and Wayfarer Movements, and by the enthusiasm with which sports and games are being taken up.

The days of rule by fear and the assegai are done with—the time for procrastination is past: if a Chief would perpetuate his royal line and preserve his tribe from complete disintegration, it is obligatory that he walk with the times. He must call to his aid the ablest brains among his people and set his heart and mind to the difficult but by no means impossible task of reorganising the tribal system on up-to-date lines. Experience suggests that alone he will not always be able to overcome the difficulties which are inseparable from the introduction of innovations amongst primitive people, but the most cordial relations which have existed for fifty years between the Chief and the Ba-ga-Malete on the one hand and the British Administration on the other should satisfy even the most exacting critic that on one side at all events the desire is strong to rehabilitate and perpetuate useful tribal institutions.

Truth is not always kind, and who will deny that more than one Chief has completely lost the grip which his predecessors had over the people? Again, the sooner that pernicious idea that a chief should enjoy all the prerogatives of chieftainship and bear none of the responsibilities of his position is dispelled, the better. Chiefs must gird up their loins and show outwardly and visibly that their lives are dedicated to the well-being and welfare of their people. Thus will their praises be sung as in the days of old.

Just as we say in English that the wealth of kings lies in the affections of their subjects, so does the Sechuana proverb say, "Kgosi ke kgosi ka Morafhe."

APPENDIX E.

Memorandum on Certain Tribal Customs and the Extent to which they have been Retained or Discarded.

1. *Rainmaking.*—The right to make rain was an essential attribute of chieftainship, and the first duty of a new chief was to learn the art of rainmaking from the "Morōka" (rainmaker). As the prosperity of the tribe depends on successful crops and plentiful pasturage for the tribal cattle, the extent to which the people looked to the chief to make rain at the right season, and the renown which attached to his name when he did so are readily understood. An account of the ceremonial in connection with rainmaking is given in the opening pages of this work.

Fhologang Pèba was "Morōka" to Chiefs Mokgosi I, Ikaneng, and Mokgosi II, but rainmaking is a thing of the past amongst the Ba-ga-Malete, and he ascribes the failure of later Chiefs to learn the secrets of rainmaking to their reluctance to remunerate the Morōka suitably!

During the chieftainship of Mokgosi II, Fhologang began to instruct

Baitlutle (the Chief's brother, and later Regent during the minority of Seboko), but Baitlutle grew afraid that Mokgosi might become jealous and accuse them both of having designs upon the chieftainship and the lessons ceased.

"After Mokgosi's death," says Fhologang, "I again went to Baitlutle, but he was no longer interested, and Seboko was never taught to make rain."

2. *Go Fhoka Marumō.*—The last time this ceremony was performed was soon after the accession of Ikaneng. "Go fhoka marumō" means to purify or cleanse the spears of the army: this was done by a doctor (Ngaka) in the Kgotla, in the presence of the whole tribe. Merafe and Pabale were the last doctors to do this at Ramoutsa.

3. *Doctoring of New Buildings.*—"Ntlo ea thaiwa ke Ngaka"—the doctor "doctors" the site for a new hut: the "Morōka" held the "Pheko ea Motse" (Dipheko tsa Motse), the horn containing the medicine for doctoring the village. The payment for doctoring a site for a new hut was an ox or a goat. When Baitlutle built the new kgotla at Ramoutsa, the site was doctored by Tsienyane, a doctor from Maanwane in the Transvaal, and this is what he did: one evening he killed a bull (any bull will do), next morning he cut it open: he severed the horns from the skull and planted them in the ground, points upward: the Chief was made to sit between the horns, and the doctor then sprinkled him and the enclosure with the sacred medicine. This ceremony was always of a private nature.

4. *Go Loma.*—The "Kgōrō" divisions (1–6) of the Ba-ga-Malete tribe are "royal" kgōrōs, and the name of "Maloma-sotse" given to their leaders is one of privilege since it singles them out as the aristocracy of the tribe.

The ancient custom of the eating of the first fruits of the season (go loma) is as follows:—

At the appearance of the new moon in the month of January, the Chief sends a messenger to his senior Headman, ordering him to eat of the first fruits: the senior Headman transmits the command to all the other "Maloma-sotse" and they "eat" of the first fruits in the order of their seniority. When the Chief's messenger returns with the senior Headman's acknowledgment, the Chief calls his own Kgōrō to "eat." The "eating" consists actually of children coming to their kgotlas, in the order of the seniority of their parents, and chewing the leaf of a small melon-like fruit called "Monyakō" which is then rubbed on the navel. In the case of adults, the woman takes the leaf and draws a cross at the bottom of the clay pots belonging to the man of the family. "Monyakō" signifies a door or an opening, and the ceremony marks the opening of the new year. The plant which produces the first fruit of the season has never been known to fail to appear. The custom is still observed though not always at the same time of the year nor as faithfully as formerly.

It is of interest to note that Mokgosi I never failed to send word to Moilwe, Chief of the Bahurutse, as soon as he had given the order to his Headmen to "loma": he did this as a mark of respect for the head of the senior of all the Bechuana tribes: the totem of the Bahurutse is the Baboon, and the Bechuana say, "Tshwene e laola dichaba tsōtlhè" (the Mohurutse is supreme amongst all tribes).

5. *Dikgafèla* (Harvest Festival).—In olden times when rains were plentiful and good crops were reaped, it was the practice for the tribe to make

gifts of grain to the Chief "to thank him for his successful rainmaking." This custom has practically died out, although in 1935 the women took grain to the Chief of their own accord.

6. *Seasonal Taboos.*—Every year when the crops stand about a foot high, the Chief gives an order prohibiting the cutting of Mogōnōnō and Mosètlha trees, for it is commonly held that if these trees are cut down at this moment the crops will be destroyed by hail. Should anyone ignore the order and the lands near by come to be destroyed or damaged by hail he will be reported to the Chief and punished. When the crops are almost ripe the Chief raises the ban, for it is from these trees that the people obtain the stakes used in the making of the "difhatana" (grain containers built to the same pattern as the roof of a hut, only inverted), into which the ears of corn are thrown as they are brought in from the lands.

The cutting down of the Mokgalō tree is also prohibited annually at the same time as the Mogōnōnō and the Mosètlha, and in this case the ban is not raised until some time later when the Chief's cattle-kraal has been repaired, for of all the thorn trees which the country produces, the Mokgalō is the most sought after for making kraals. The tree is called "Mokgalō wa Kgosi."

7. *Placing Stones in Trees.*—It was customary for persons approaching a village to pick up a stone and place it in the fork of a tree by the road-side as an earnest of their hopes that the persons they were visiting would have a plentiful supply of food on hand. This custom is no longer carried out.

8. *Marriage.*—Most marriages amongst the Ba-ga-Malete are still celebrated "according to Native Custom," which here has hardly changed, and is shortly as follows:—

The boy's father approaches the parents of the maiden, and if they are agreeable to the match he returns home to tell his wife and relatives. When the time for the marriage comes the bridegroom's maternal uncle, his other male relatives and friends, go to the home of the bride's parents (ba ea go batla); this visit takes place in the morning; the womenfolk go in the afternoon (ba ea go nèsa pula). That night, the bridegroom is escorted to the bride's hut by his paternal uncle—formerly the young man carried his skin blanket (Mosare) over his shoulder, but modern girls are more exacting and blankets, sheets, pillows, etc., are conveyed to the bride's hut during the day. On reaching the hut the bridegroom's escort says, "Kgomo e tebelebe" (a beast of such and such a colour, naming the colour); this beast is a present from the bridegroom's parents to the bride's maternal uncle, and may be delivered to him at any time as long as its colour has been given. The escort then leaves the bridegroom in the hut with his bride; if she has been sharing the hut with her parents or other members of her family these find accommodation elsewhere. Next morning the man gets up very early, for he must return to light the fire in his own kgotla—he must continue to rise early for some time (not specified), as it is not considered fitting that any member of his wife's family should see him in bed. Later on, the bride's parents take her to her husband's parents and she stays with them for a while before returning to her own home, where she will then remain until she has one or two or more children, when her husband will set about the task of building a hut for himself and his

family at his kgotla. Actually his wife builds the wall of the hut and does all the plastering and smearing, and she may be assisted in this by her mother and sisters; the husband is responsible for supplying the rafters, door-frame and door, and doing the thatching.

9. *Bogadi.*—Bogadi figures in nearly all Ba-ga-Malete marriages—even in those cases where the parties have been married in Church or by the Magistrate. Delivery of the bogadi as a condition precedent to marriage has never been enforced, and the time when a husband will make every effort to meet his obligation in this respect is when his eldest daughter comes to get married, for so long as he has not paid bogadi his children cannot be claimed by him or by his family—they belong to his wife's family and to them goes the bogadi—whatever is decided upon—when the female children marry. As long as bogadi remains unpaid, the children are referred to as "Malebèlèdi a senang bogadi" (those awaiting the payment of bogadi).

10. *Burial.*—In the old days the dead were buried in a sitting position, arms and legs bound to the trunk by means of bark thongs, fists placed under the chin, resting on the drawn-up knees; the body faced not quite to the east but towards that part of the Marico River where the tribe has come from. A man's sandals were hung on his left arm—his weapons were not buried, but distributed among his male relatives; the maternal uncle or, if he was dead, the grandfather, inheriting the deceased's shield, his battle-axe, and one spear. The grave was circular and shallow and was doctored before the body was placed in it. Women were buried in the same way as men. The widow and/or other relatives occupying the hut continue to live in it, for the Ba-ga-Malete say they have no ghosts. Only the Chief and his sons are buried in the royal cattle-kraal; a Chief's body was wrapped up in one of his skin blankets, care being taken to see that it was one made from the hide of a black ox. The "Morōka," although not entitled to a place beside the royal dead, was the only member of the tribe to be buried in the skin of a black bull. To-day the dead are buried lying down—sometimes a niche is excavated in the north wall of the grave and sometimes a coffin is provided.

11. *Bogwèra and Boyale.*—The Ba-ga-Malete actively practise the traditional custom of initiation (Bogwèra for males and Boyalè for females)—that great barrier on one side of which stand all children, and on the other those who have "come of age" and qualified for the privileges and obligations of true native citizenship, membership of an age-unit (mophato), the right to marry, and for the men the further right to attend the kgotla and other tribal meetings and take part in their deliberations.

The ceremonies normally take place every four or five years in the months following the reaping of the crops; the unit or mophato which is formed immediately upon the termination of the period of initiation is basically an age-group, the leader of which is not its oldest member but the senior by right of birth, consequently a Chief's sons and daughters are invariably leaders of age-units.

The great importance attached to these rites has lost little of its appeal to the Ba-ga-Malete, and few of their children fail to respond to that inward call which bids them adhere to the code of their forefathers, but those who eschew this "relic of barbarism" are able to take advantage of

legislation * "prohibiting the performance among native tribes of rites of circumcision or initiation on young persons without the consent of their parents or guardians."

LIST OF MEN'S REGIMENTS.

?1795. *MaNōga* ("The snakes").

Initiated at Lotlhakane during reign of Mokgōywe-a-Pooè; leader Pooè-a-Mokgōywe, eldest son in the 1st house of Mokgōywe-a-Pooè.

Explanation of Name: A snake was killed while the *bogwera* was being held.

?1800. *MaFhiri* ("The hyenas").

Initiated at Lotlhakane during reign of Mokgōywe-a-Pooè; leader Tsièpanè, younger brother of Tsièpe, both sons of Mokgōywe-a-Pooè.

Explanation of Name: A hyena was killed while the *bogwera* was being held.

?1805. *Mathubapula* ("The destroyers of rain").

Initiated at Lotlhakane during reign of Pooè-a-Mokgōywe; leader Mmolotsi, third son in the 1st house of Mokgōywe-a-Pooè.

Explanation of Name: Someone may have broken the sacred rain-pot.

?1810. *MaTsaakgang* (*Ma-Tsaea-kgang*) ("Those associated with dispute").

Initiated at Lotlhakane during reign of Pooè-a-Mokgōywe; leader Mokgosi, elder son in the 1st house of Pooè-a-Mokgōywe.

?1815. *MaLau* ("The lions").

Initiated at Lotlhakane during reign of Pooè-a-Mokgōywe; leader Moetshwe, eldest son, 2nd house, of Pooè-a-Mokgōywe.

Explanation of Name: A lion was killed while the *bogwera* was being held.

?1820. *Madikwa* ("The Marico River").

Initiated at ? during reign of Pooè-a-Mokgōywe; leader Kedimotse, younger son, 1st house, of Pooè-a-Mokgōywe.

Explanation of Name: First *bogwera* held after the destruction of Pooè's village (Lotlhakane) by the Bahurutse and their allies in 1816 or 1817.

?1828. *Malomakgomo* (*Ma-loma-kgomo*) ("The first to taste beef").

Initiated in the veld during the reign of Pooè-a-Mokgōywe; leader Mogopudi, son of Pooènyane.

Explanation: The tribe was still scattered; they were practically without cattle and were living on game meat.

?1834. *MaIpofi* (*Ma-ipofi*) ("Those who tie themselves round").

Initiated at Rabogadi during reign of Mokgosi I; leader Kobuane, son of Pooè-a-Mokgōywe's 5th house.

Explanation: First *bogwera* after Mokgosi had started to gather up the scattered members of the tribe. Food was scarce, of cattle they still had none, and they had to pull up their belts.

?1840. *MaNōga* ("The snakes").

Initiated at Rakatana during reign of Mokgosi I; leader Pooè-a-Mokgosi, elder son, 2nd house, of Mokgosi I.

Following tradition they took the name of the regiment of their leader's ancestor (Pooè-a-Mokgōywe).

* Proclamation No. 41. of 1917.

?1846. *Mayakgomo* (*Ma-ya-kgomo*) ("The eaters of cattle").

Initiated at Lobudeng during reign of Mokgosi I; leader Porogwe, son of Kedimotse.

1853. *Maatswakgosi* (*Ma-atswa-kgosi*) ("Those who restore the prestige of the Chief").

Initiated at Dithèyane during reign of Mokgosi I; leader Ikaneng, son of the 1st house of Mokgosi I.

Explanation: Since the last *bogwera*, Pooè had quarrelled with his father Mokgosi and gone off to De Aar with part of his regiment (the *MaNōga*). Mokgosi remained in distress (*a sala mo mokodueng*), but now the loss of the *MaNōga* was being made good.

?1857. *Mayapóó* (*Ma-ya-póó*) ("Those who eat of the bull").

Initiated at Dithèyane during reign of Mokgosi I; leader Mokalakane, 2nd son, 3rd house, of Mokgosi I.

Explanation: Should have been called *MaGapakgomo* ("cattle raiders"), but a *bogwera* was being held at Manyana and the father of one of the boys had killed a bull for the *bogwera*; the Manyana regiment was called *MaYapóó*, and the Ba-ga-Malete copied the name because of the proximity of the two "schools" and the fact that they were held simultaneously.

?1861. *MaTlhoare* ("The pythons").

Initiated at Dithèyane during reign of Mokgosi I; leader Diyèlwang, 3rd son, 3rd house, of Mokgosi I.

Explanation: A python was killed by the boys during the *bogwera*.

?1866. *Maakatladi* (*Ma-ea-ka-tladi*) ("Those circumcised at the time of the lightning").

Initiated at Mankgodi during reign of Mokgosi I; leader Mosikari, son of Ketsositse; * *cf.* genealogical table annexed hereto.

Explanation: Mokgosi's cattle were killed by lightning said to have been sent down by Mokodumetse, a MoRirima from the east who was at that time living at Kontlè's (Goo Manyana) on the Kolobeng River.

?1871. *Maakakgang* (*Ma-ea-ka-kgang*) ("Those who follow the dispute").

Initiated at Mankgodi during reign of Mokgosi I; leader Mokgotlhè, son of Kobuane and grandson of Pooè-a-Mokgōywe through that Chief's 5th house.

Explanation: After the Ba-ga-Malete had left Dithèyane (1863), Sechele called Gaseitsiwe to mark the BaKwena-BaNgwaketse boundary. This regiment was called *MaAkakgang* following upon the dispute which led up to the demarcation of the boundary.

?1876. *Maakantwa* (*Ma-ea-ka-ntwa*) ("Those whose initiation is associated with fighting").

Initiated at Ramoutsa during reign of Mokgosi I; leader Mokgosi, eldest son, 1st house, of Ikaneng.

Explanation: Initiated during the fighting between Sechele of the BaKwena and Lentswe of the BaKgatla.

?1881. *Maabantwa* (*Ma-aba-ntwa*) ("Those who give battle").

Initiated during reign of Mokgosi I; leader Baitlutle, 2nd son, 1st house, of Ikaneng.

Explanation: Initiated at the time when rumours of an attack on Ramoutsa

* Senewanyane, although "betrothed" to Mokgosi, got herself into trouble, and when the Chief sent for her she had borne a male child named Ketsositse. After the Chief had formally taken her to wife Senewanyane bore him Ikaneng and Ikalafeng.

by the BaNgwaketsi were circulating. The *bogwera* was just over when the attack was made.

?1887. *Mafhitlakgosi* ("Those who bury the Chief").

Initiated at Ramoutsa during reign of Ikaneng; leader Montsiwa, 3rd son, 1st house, of Ikaneng.

Explanation: The *bogwera* was postponed because of the death of Mokgosi I. Many boys ran away to LeHurutse and were initiated into the BaHurutse regiment of *MaGanelwa*.

?1890. *Maakapula* (*Ma-ea-ka-pula*) ("Those who go with the rain").

Initiated at Ramoutsa during reign of Ikaneng; leader Keshupilwe, 4th son, 1st house, of Ikaneng.

Explanation: Very heavy rains fell during this year and the springs and fountains were all revived.

1894. *Malwelamotse* (*Ma-lwela-motse*) ("Those who quarrel over the village").

Initiated at Ramoutsa during reign of Ikaneng; leader Kelepile, eldest son of Mosikari. *Cf.* genealogical table annexed hereto.

Explanation: So named after the split in the tribe following upon the dispute between Ikaneng and Pule and the departure of the latter after Ikaneng had been declared rightful Chief of the tribe.

1900. *Maakathata* (*Ma-ea-ka-thata*) ("Those who go through troubled times").

Initiated at Ramoutsa during reign of Mokgosi II; leader Ranko, 2nd son of Mosikari. *Cf.* genealogical table annexed hereto.

Explanation: This *bogwera* was held during the Anglo-Boer War when there were Boer commandoes and camps along the Bechuanaland-Transvaal border. Fears were expressed that if fighting broke out the *bogwera* might be invaded; but this did not happen.

1907. *Maganakgosi* ("Those who refuse to wait for the Chief").

Initiated at Ramoutsa during reign of Baitlutle; leader Ramontshonyane, 3rd son of Mosikari. *Cf.* genealogical table annexed hereto.

Explanation: Mokgosi II postponed the *bogwera* because his son Seboko was too young. There were complaints, as many of the boys were getting past the age for circumcision. The death of Mokgosi caused more delay, some of the people holding that no *bogwera* could be held during the period of mourning. Eventually, however, it was decided to have a *bogwera* for the oldest boys only. This regiment was subsequently incorporated into the *MaSutlakgosi*.

1910. *Masutlakgosi* ("Those who make way for the Chief").

Initiated at Ramoutsa during reign of Baitlutle; leader Seboko Mokgosi, elder son, 1st house, of Mokgosi II.

Explanation: When this regiment emerged from the *bogwera*, the *MaGanakgosi* wanted Seboko to become their leader as he should have been by rights, but he refused and a compromise was sought by seeking to transfer to the *MaSutlakgosi* those members of the *MaGanakgosi* of Seboko's age, but as they were less than twenty in number it was decided in the end to merge the whole of the *MaGanakgosi* into the *MaSutlakgosi*.

1916. *Matloladibe* ("Those who go through bad times").

Initiated at Ramoutsa during reign of Baitlutle; leader Ketswerebothata, eldest son, 2nd house, of Mokgosi II.

Explanation: This was a famine year and part of the tribe wanted to postpone the *bogwera* until 1917, but this would have given rise to complications, as Seboko

was to assume the chieftainship in that year, and following traditional custom the first initiation after the accession of a new chief must be a *boyale*.

1921. *Mashelwa* ("Those who are burnt out").

Initiated at Ramoutsa during reign of Seboko; leader Sefengwane, 3rd son, 2nd house, of Makgosi II.

1923. *Mashelwa* ("Those who are burnt out").

Initiated at Ramoutsa during reign of Seboko; leader Kobue, son of Kobe, son of Sebodu, 2nd son of Mokgosi's 4th house.

Explanation: One night a gale sprang up and the shelters of the *bogwera* were burnt out. Such a thing had never been known to happen before. A second *bogwera* was necessary because many of the boys had run away to the diamond diggings and to farms, etc., in the Transvaal, and on their return home they were found to be sufficiently numerous to justify a special *bogwera*. They subsequently amalgamated and were thus brought into line with their age-companions initiated in 1921.

1925. *Mantswabisi* (*go swabisa kgosi*, "to cause the Chief sorrow").

Initiated at Ramoutsa during reign of Seboko; leader Rantsodimana, elder son of Mothibi Porogwane, grandson of Mokgosi I in the 5th house.

Explanations: (*a*) The BaNgwaketsi had complained that the Ba-ga-Malete put BaNgwaketse boys into their *bogwera*. The Ba-ga-Malete answered that those who came unaccompanied by their parents were not admitted to the *bogwera*.

(*b*) Two Ba-ga-Malete boys (Spence and Lokwane), with a *legwane* (uninitiated boy, Spence's younger brother), stole and killed some cattle belonging to a farmer in the Transvaal. The Transvaal authorities wanted the boy as a witness, but as he had been admitted to the *bogwera* the Chief and his headmen journeyed to Gaberones to explain that it was impossible to produce the boy until the ceremonies were over. The regiment was called *MaNtswabisi* because of these difficulties with the authorities.

1929. *Matsaakgang* (*Ma-tsaea-kgang*) ("Those associated with a dispute").

Initiated at Ramoutsa during reign of Seboko; leader Rantleru Mothibi, grandson of Porogwane, eldest son of Mokgosi I by his 5th wife Matlafela.

Explanation: A Molete boy who had been attending school in the Transvaal came to Ramoutsa with letters of introduction to the Missionary of the Lutheran Church, who admitted him to the Ba-ga-Malete school. The boy's father removed him from school to the *bogwera*, saying he had not consented to his son becoming a member of the Church. The Missionary and the Magistrate tried to have the boy brought back from the *bogwera*, but the Chief refused. There was a big dispute over this.

1933. *Mantsakgosi* ("Those associated with the loss of the Chief's powers").

Initiated at Ramoutsa during reign of Seboko; leader Ramhengwa Moleke, 2nd son of Ranko Mosikari. *Cf.* genealogical table annexed hereto.

Explanation: Thus named from the uneasiness caused to the Chief by the proposed promulgation by Government of a Proclamation defining the powers of Chiefs.

LIST OF WOMEN'S REGIMENTS.

(*Note.*—The words *a basadi*, "of the women," suffixed to the name of a regiment indicates that it was formed just after, and named after, the corresponding men's regiments, *q.v.* for the meaning and explanation of the regimental name.)

1854. *Maatswakgosi (a basadi).*
Initiated at Dithèyane during reign of Mokgosi I; leader Polo, elder daughter of Kedimotse.

?1862. *MaTlhoare (a basadi).*
Initiated at Dithèyane during reign of Mokgosi I; leader Sankgotshane, younger daughter of Kedimotse.

?1867. *Maakatladi (a basadi).*
Initiated at Mankgodi during reign of Mokgosi I; leader Sebenyana, younger daughter, 3rd house, of Mokgosi I.

?1872. *Maakakgang (a basadi).*
Initiated at Mankgodi during reign of Mokgosi I; leader Selotlegeng, Mokgosi's daughter, 7th house.

?1877. *Maakantwa (a basadi).*
Initiated at Ramoutsa during reign of Mokgosi I; leader Seiso, daughter of Mokgoywe, Mokgosi's elder son in 4th house.

1878. *Maanosi* ("Those who go alone").
Initiated at Ramoutsa during reign of Mokgosi I; leader Manang, younger daughter of Seleke, younger brother of Mogopudi, son of Pooènyana, 2nd son of 1st house of Mokgoywe-a-Pooè.
Explanation: No males of initiation age.

?1882. *Maabantwa (a basadi).*
Initiated at Ramoutsa during reign of Mokgosi I; leader Moabi, daughter of Kobuane, son of Pooè-a-Mokgoywe's 5th house.

?1888. *Mafhitlakgosi (a basadi).*
Initiated at Ramoutsa during reign of Ikaneng; leader Keutluile, eldest daughter, 2nd house, of Mokgosi I.

?1891. *Maeakapula (a basadi).*
Initiated at Ramoutsa during reign of Ikaneng; leader Sediko, daughter of Mokgoywe, son of 4th house of Mokgosi I.

1892. *MaHaisi* ("Those of the house") (*Haisi* is a corruption of the Afrikaans word *huis.*)
Initiated at Ramoutsa during reign of Ikaneng; leader Tsètsane, daughter of Mokalakane, 2nd son, 2nd house, of Mokgosi I.
Explanation: Initiated at time when a house in the European style was being built for Ikaneng. (This house was still standing in 1935.)

1895. *Malwelamotse (a basadi).*
Initiated at Ramoutsa during reign of Ikaneng; leader Matlafele, elder daughter of Ikaneng in the 1st house.

1898. *Maeanosi* ("Those who go alone").
Initiated at Ramoutsa during reign of Ikaneng; leader Khufang, daughter of Ditlhakeng, younger brother of Modingwane, great-great-grandson of Mokgoywe-a-Pooè by his 3rd house.
Explanation: No males of initiation age.

1901. *Maakathata (a basadi).*

Initiated at Ramoutsa during reign of Mokgosi II; leader Inakaje, younger daughter, 1st house, of Ikaneng.

1907. *Maganakgosi (a basadi).*

Initiated at Ramoutsa during reign of Baitlutle; leader MmaMorotologa, daughter of Kole, son of Mogopudi, son of Pooënyane.

1908. *Maganakgosi (a basadi).*

Initiated at Ramoutsa during reign of Baitlutle; leader Makabetlwane or MmaLekgalagadi, 3rd daughter of Ikaneng's 2nd house.

Cf. explanation of this name given above for the corresponding men's regiment. The same urgency for initiation prevailed as regards the girls, for it was still considered shameful for a girl to have a baby before she had been initiated. As there were many girls it was necessary to hold two *boyales*. These groups were subsequently incorporated into the *Masutlakgosi*.

1909. *Masutlakgosi (a basadi).*

Initiated at Ramoutsa during reign of Baitlutle; leader MmaKotswe, daughter of Baitlutle, who, after amalgamation of the *Maganakgosi*, became leader of the united regiments.

1917. *Matloladibe (a basadi).*

Initiated at Ramoutsa during reign of Seboko; leader Nkgabe, daughter of Tsebempe, son of Ikaneng by MmaMosikari (Nkgabe). *Cf.* genealogical table annexed hereto.

1922. *Mashelwa (a basadi).*

Initiated at Ramoutsa during reign of Seboko; leader Kgampane, daughter of Kgosane, 2nd house of Ikaneng.

1925. *Mantswabisi (a basadi).*

Initiated at Ramoutsa during reign of Seboko; leader Ntshadi, daughter of Marang, son of Ikaneng and Nkgabe. *Cf.* genealogical table annexed hereto.

1929. *Matsaakgang (a basadi).*

Initiated at Ramoutsa during reign of Seboko; leader Konapedi, daughter of Ranko Mosikari. *Cf.* genealogical table annexed hereto.

1934. *Mantsakgosi (a basadi).*

Initiated at Ramoutsa during reign of Seboko; leader Matlatsana (Enid), eldest daughter of Chief Seboko.

GENEALOGICAL TABLE.

(To show descent of leaders of male and female regiments.)

? × Senewanyane × Mokgosi I

Ketsositse × Nkgabe × Ikaneng — Ikaneng — Ikalafeng

Mosikari [1] — Marang (boy), Tsebempe (boy), Lesatsopa (girl), Matale (boy), Sekgatlanye (boy) — Mokgosi II

Kelepile [2] — Ranko [3] — Ramontsonyana [4] — Seboko

Kgongwane — Konapedi [5] — Ramhengwa [6] — Mokgosi

[1] Leader of Maakatladi.
[2] ,, Malwelamotse.
[3] ,, Maakathata.
[4] Leader of Maganakgosi.
[5] ,, Matsaakgang.
[6] ,, Mantsakgosi.

APPENDIX F.

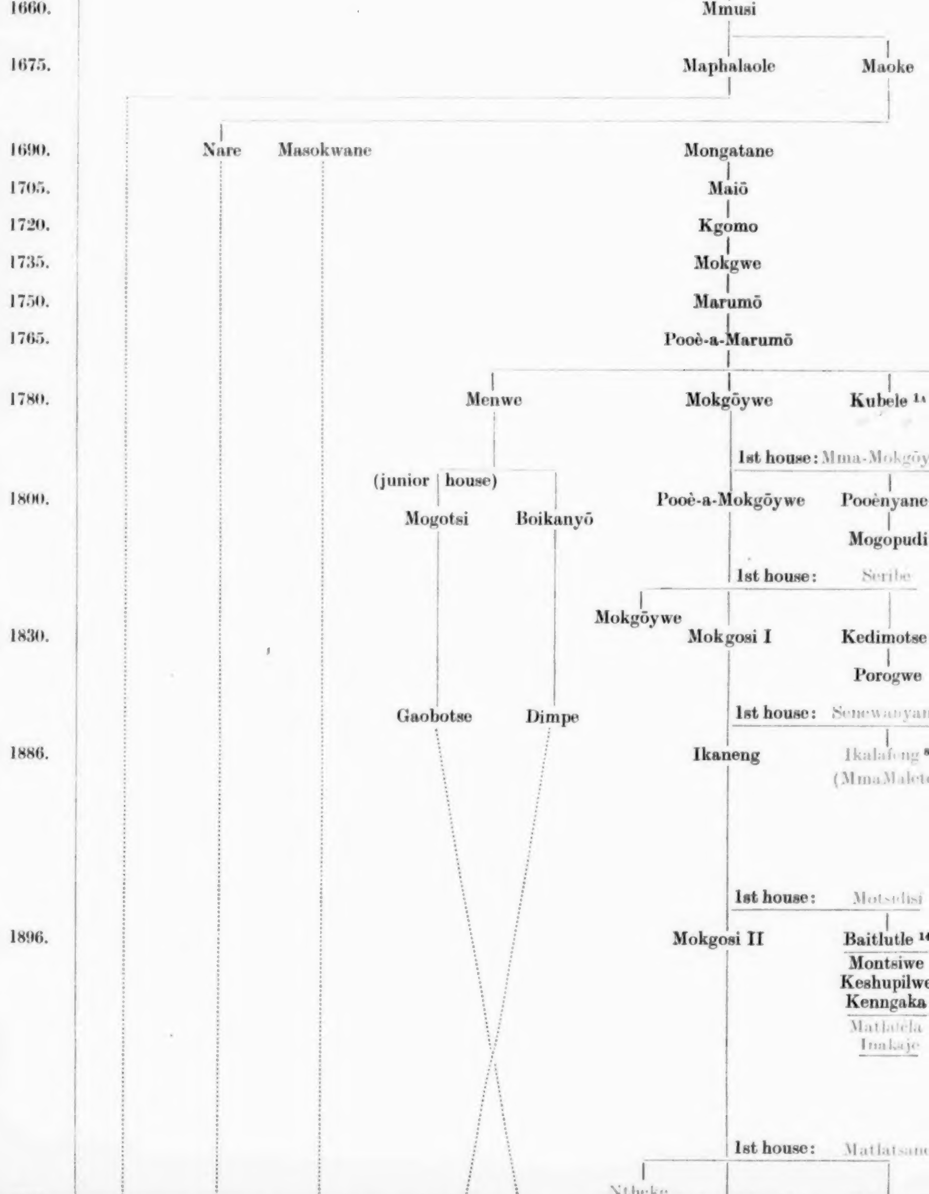
BA-GA-MALETE TRIBE: 1936 CENSUS.

Tribal Division.	of	Head.	Males.				Total males.	Females.				Total females.	Total population.	Educational.					
			Unweaned babies.	Under 16.	Over 16.	Old men.		Unweaned babies.	Under 16.	Over 16.	Old women.			Literate.		Total.	Illiterate.		Total.
														M.	F.		M.	F.	
Kgōrō.	Mpya (Nca).	Gei Kgetbeng.	67	252	139	21	479	55	225	301	47	628	1107	33	52	85	446	576	1022
Kgōrō.	Nare.	Seokope Moepi.	11	44	21	1	77	6	48	50	5	109	186	9	15	24	68	94	162
Kgōrō.	Mankga.	Kealeboga Moagi.	8	37	39	2	86	5	36	57	5	103	189	23	35	58	63	68	131
Kgōrō.	Menwe.	Ephraim Katse.	11	79	55	3	148	14	94	78	11	197	345	43	21	64	105	176	281
Kgōrō.	Gaobotse.	Mokgalagadi Gaobotse.	3	7	49	..	59	8	10	68	1	87	146	9	6	15	50	81	131
Kgōrō.	Mokgwa (Kgosing).	Chief Seboko Mokgosi.	42	284	247	5	578	49	268	326	6	649	1227	98	94	192	480	555	1035
Kkgotlana.	Ea Magadingwana.	Lokote Motladiile.	16	63	62	..	141	19	59	104	..	182	323	43	51	94	98	131	229
Kkgotlana.	Ea Madisakwane.	Radikōta Magosi.	6	22	17	..	45	3	23	30	2	58	103	6	8	14	39	50	89
Kkgotlana.	Ea Letsèkèla.	Maletenyana Tsetse.	18	94	44	6	162	23	74	92	7	196	358	21	44	65	141	152	293
Sub-Kgōrō.	Marungwana.	Mokatisi Phelehu.	17	41	37	2	97	11	36	63	1	111	208	17	15	32	80	96	176
Sub-Kgōrō.	Moeng.	Ramontso Motshwaedi.	25	100	112	3	240	20	102	156	5	283	523	30	22	52	210	261	471
Kkgotlana.	Ea ba-Kweneng.	Rakola Ntsuape.	7	33	35	..	75	5	26	37	1	69	144	3	..	3	72	69	141
Sub-Kgōrō.	Ea Tauana.	Tsebe Kgari.	3	24	32	1	60	14	21	37	9	81	141	2	3	5	58	78	136
Sub-Kgōrō.	Boo rra Sebogodi.	Mokwalare Moilwa.	19	113	69	..	201	24	114	119	1	258	459	24	19	43	177	239	416
Sub-Kgōrō.	Ba-ga-MmaMokanō.	Tiro Ramogotsi.	11	36	24	..	71	7	30	41	..	78	149	9	..	9	62	78	140
Kgōrō.	Nōga.	Molefe Botlhole.	6	41	34	..	81	5	37	56	10	108	189	10	16	26	71	92	163
			270	1270	1016	44	2600	268	1203	1615	111	3197	5797	380	401	781	2220	2796	5016

Horses and Mules .	17
Donkeys . . .	111
Cattle . . .	10,825
Sheep . . .	2,293
Goats . . .	4,004
Ploughs . . .	587
Wagons . . .	67

Absentee Members:—

Mines .	550	
Farm Work .	67	
Visiting .	11	
Miscellaneous .	145	773
Total Population		6570


1555.
Badimo
1570.
Phatle
1585.
Malete-a-Phatle
1600.
Lesokwane
1615.
Mokgoare
1630.
Mogope
1645.
Dire
1660.
Mmusi
1675.
Maphalaole
Maoke
1690.
Nare
Masokwane
Mongatane
1705.
Maiō
1720.
Kgomo
1735.
Mokgwe
1750.
Marumō
1765.
Pooè-a-Marumō
1780.
Menwe
Mokgōywe
Kubele
1st house:
(junior house)
1800.
Pooè-a-Mokgōywe
Pooènyane
Mogotsi
Boikanyō
Mogopudi
1st house:
Seribe
Mokgōywe
1830.
Mokgosi I
Kedimotse
Porogwe
1st house:
Gaobotse
Dimpe
1886.
Ikaneng
1st house:
1896.
Mokgosi II
Montsiwe
Kenngaka
1st house:
Ntheke
1917.

APPENDIX G.

Genealogical Table.

[1A] Descendant (1935): Headman Kgwedi Masi.
[1] " Headman Radikota Mag
[2] " Headman Sekgere Madi
[3] " Headman Lokote Motla
[4] " Headman Nkoane Porog
[5] " Headman Letsebe Phetw
[6] " Headman Mogopodi Seg
[7] " Headman Masokwane,
Pule, who left the tribe in 1888 or 1889 a
at Gabane on the 24th November 1911.
[8] Married Mosielele, father of Headman Gobu
now living at GaThamaga, Bakwena Rese
[9] Mother of Headman Kgosiemang of Molepol
Motswakhumo of Ntswe-le-tau, Bakwena
[10] Died at Modipe.
[11] Living at Haartebeestfontein, Transvaal.
[12] Father of Headman Adolph Mokgosi.
[13] Mother of Headman Lokote Motladiile.
[14] Regent, 1906–1917.
[15] Heir to the Chieftainship. Born in 1922.
[16] Descendant (1935): Rantleru Mothibi.
[17] Mother of Headman Kealeboga Moagi.

Names in red signify females.
Names underlined thus ———— = alive in 1

Maoke

Kubele [1A] | Magōgwe [1] | 2nd house Tsièpè
Nkwè-a-Magogwe | Tsièpane

se: Mma-Mokgōywe | 2nd house Tswenyane-a-Dita

re | Pooènyane [2] | Mmolotsi | Modingwane [3]

Mogopudi

se: Seribe | 2nd house Lesarwe | 3rd house Nkudube | 4th house Mma-Morwa | 5th house Moabi

Kedimotse [4] | Moètshwe | Phetwe [5] | Segolabeng [6] | Kobuane [7]

Porogwe

se: Senewanyane | 2nd house Moètsenyane | 3rd house Mangaka | 4th house Sediko | 5th house Matlafela | 6th house Tloto | 7th house Motsetselele | 8th house Mmamokae | 9th house Lekgōane | 10

Ikalafeng [8] (MmaMalete) | Pooè-a-Mokgosi Mmolotsi Ntheke [9] | Mokalake [10] Mokalakane Dijelwang Sebe Sebenyane | Mokgōywe Sebodu Pulane Malebo [11] (Mma-Motsage) | Porogwane [16] Nthekane Nthwe [12] Bogosi Seyamobolo Seikgomeng [13] | Sebitso Sebitsonyane Gabaediwe Magoma Tsonokwane Rampatso | Moilamashi Selotlegeng Morea kgotla | Seoposengwe Kebarebotse | Siitiso [17] Mmanape | Mo

se: Motsedisi | 2nd house Kgampane

Baitlutle [14] Montsiwe Keshupilwe Kenngaka Matlatela Inakaje | Keutluile Kgosiemang Kgosane Mayang Shepherd Makabetlwane (Mma Lekgalagadi) Ikalafeng Mayako

se: Matlatsane | 2nd house Mothee | 3rd house Khufang

Selekeng | Ketswerebothata | Lokoto

1917 Ntheke Seboko Mokgosi

APPENDIX G.

Genealogical Table.

Magōgwe [1]
Nkwè-a-Magogwe
Mmolotsi

2nd house
Tsièpè
Tsièpane

2nd house
Tswenyane-a-Dira
Modingwane [3]

2nd house
Lesarwe
Moètshwe

3rd house
Nkudube
Phetwe [5]

4th house
Mma-Morwa
Segolabeng [6]

5th house
Moabi
Kobuane [7]

2nd house
Moetsenyane
Pooè-a-Mokgosi
Mmolotsi
Ntheke [9]

3rd house
Mangaka
Mokalake [10]
Mokalakane
Dijelwang
Sebe
Sebenyane

4th house
Sediko
Mokgōywe
Sebodu
Pulane
Malebo [11]
(Mma-Motsage)

5th house
Matlafela
Porogwane [16]
Nthèkane
'Nthwe [12]
Bogosi
Seyamoholo
Seikgomeng [13]

6th hou…
Thoto
Sebits…
Sebitsony…
Gabaedi…
Magon…
Tsonokw…
Rampa…

2nd house
Kgampane
Keutlule
Kgosiemang
Kgosane
Mayang
Shepherd
Makabetlwane (Mma Lekgalagadi)
Ikalafeng
Mayako

2nd house
Mothee

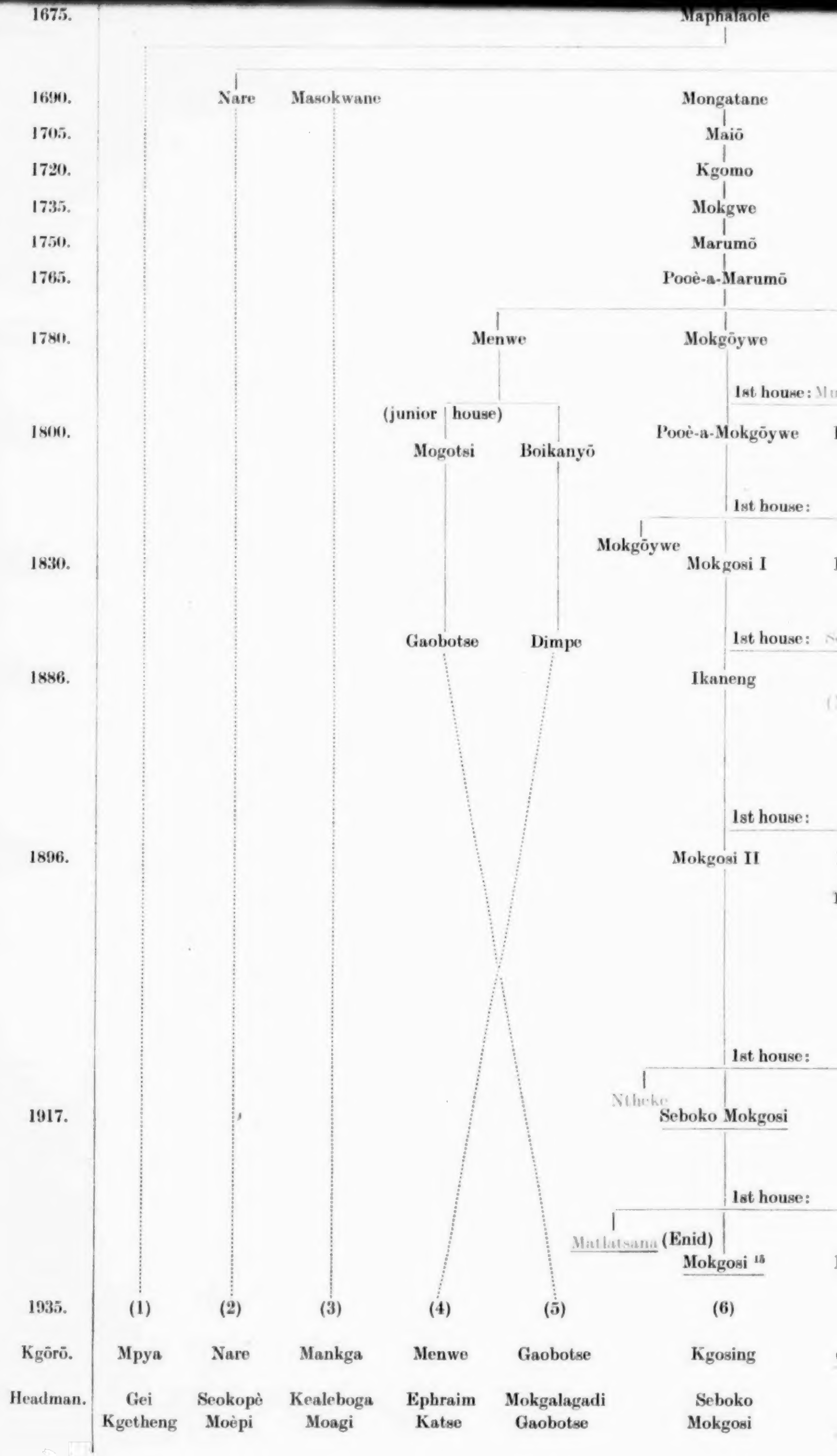
3rd house
Khufang

Selokeng Ketawerabothata Lokote

[1A] Descendant (1935): Headman Kgwedi Masi.
[1] ,, Headman Radikota Magosi.
[2] ,, Headman Sekgere Madimabe.
[3] ,, Headman Lokote Motladiile.
[4] ,, Headman Nkoane Porogwe.
[5] ,, Headman Letsebe Phetwe.
[6] ,, Headman Mogopodi Segolabeng.
[7] ,, Headman Masokwane, son of Pule, who left the tribe in 1888 or 1889 and died at Gabane on the 24th November 1911.
[8] Married Mosielele, father of Headman Gobuamang, now living at GaThamaga, Bakwena Reserve.
[9] Mother of Headman Kgosiemang of Molepolole and Motswakhumo of Ntswe-le-tau, Bakwena Reserve.
[10] Died at Modipe.
[11] Living at Haartebeestfontein, Transvaal.
[12] Father of Headman Adolph Mokgosi.
[13] Mother of Headman Lokote Motladiile.
[14] Regent, 1906–1917.
[15] Heir to the Chieftainship. Born in 1922.
[16] Descendant (1935): Rantleru Mothibi.
[17] Mother of Headman Kealeboga Moagi.

Names in red signify females.
Names underlined thus ——— = alive in 1935.

...th house	7th house	8th house	9th house	10th house
Thoto	Motsetselele	Mmamokae	Lekgoane	Mmaphare
Sebitso	Moilamashi	Seoposengwe	Siitiso [17]	Monnaamere
...bitsonyane	Selotlegeng	Kebarebotse	Mmanape	Mogopa
...abaediwe	Morea kgotla			Ratsoku
Magoma				Rannõgõ
...sonokwane				
Rampatso				



1675.
Maphalaole
1690.
Nare
Masokwane
Mongatane
1705.
Maiō
1720.
Kgomo
1735.
Mokgwe
1750.
Marumō
1765.
Pooè-a-Marumō
1780.
Menwe
Mokgōywe
1st house:
(junior house)
1800.
Mogotsi
Boikanyō
Pooè-a-Mokgōywe
1st house:
Mokgōywe
1830.
Mokgosi I
Gaobotse
Dimpe
1st house:
1886.
Ikaneng
1st house:
1896.
Mokgosi II
1st house:
Ntheke
1917.
Seboko Mokgosi
1st house:
Matlatsana (Enid)
Mokgosi [15]
1935.
(1)
(2)
(3)
(4)
(5)
(6)
Kgōrō.
Mpya
Nare
Mankga
Menwe
Gaobotse
Kgosing
Headman.
Gei Kgetheng
Seokopè Moèpi
Kealeboga Moagi
Ephraim Katse
Mokgalagadi Gaobotse
Seboko Mokgosi

Maoke

[10] Died at Modipe.
[11] Living at Haartebeestfontein, Transvaa
[12] Father of Headman Adolph Mokgosi.
[13] Mother of Headman Lokote Motladiile.
[14] Regent, 1906–1917.
[15] Heir to the Chieftainship. Born in 19
[16] Descendant (1935): Rantleru Mothibi.
[17] Mother of Headman Kealeboga Moagi.

Names in red signify females.
Names underlined thus ——— = aliv

Kubele [1A]
Magōgwe [1]
Nkwè-a-Magogwe
2nd house
Tsièpè
Tsièpane

se: Mma-Mokgōywe
2nd house
Tswenyane-a-Dira

e
Pooènyane [2]
Mogopudi
Mmolotsi
Modingwane [3]

se: Seribe
2nd house
Lesarwe
3rd house
Nkudube
4th house
Mma-Morwa
5th house
Moabi

Kedimotse [4]
Porogwe
Moètshwe
Phetwe [5]
Segolabeng [6]
Kobuane [7]

se: Senewanyane
Ikalafeng [8]
(MmaMalete)

2nd house
Moetsenyane
Pooè-a-Mokgosi
Mmolotsi
Ntheke [9]

3rd house
Mangaka
Mokalake [10]
Mokalakane
Dijelwang
Sebe
Sebenyane

4th house
Sediko
Mokgōywe
Sebodu
Pulane
Malebo [11]
(Mma-Motsage)

5th house
Matlafela
Porogwane [16]
Nthekane
Nthwe [12]
Bogosi
Seyamoholo
Seikgomeng [13]

6th house
Thoto
Sebitso
Sebitsonyane
Gabaediwe
Magoma
Tsonokwane
Rampatso

7th house
Motsetsebele
Moilamashi
Selotlegeng
Morea kgotla

8th house
Mmamokae
Seopeseengwe
Kebareboitse

9th house
Lekgoane
Sitiso [17]
Mmanap

se: Motsidisi
Baitlutle [14]
Montsiwe
Keshupilwe
Kenngaka
Matlafela
Inakaje

2nd house
Kgampane
Keutluile
Kgosiemang
Kgosane
Mayang
Shepherd
Makabetlwane (Mma Lekgalagadi)
Ikalafeng
Mayako

se: Matlatsane
Selekeng

2nd house
Mothee
Ketswerebothata
Sefèmo
Sefèngwane
Peloakgosi

3rd house
Khufang
Lekote

se: Boikhutso
Kelemogile
Dikhudu
Sedulo
Difako
Gaogolèlwe
Nakedi
Bogatsu
Kelèkwang

Motswakhumo of Ntswe-le-tau, Bakwena Reserve.
[10] Died at Modipo.

2nd house
Tsièpè
Tsièpane

Magōgwe [1]
Nkwè-a-Magogwe

2nd house
Tswenyane-a-Dira
Modingwane [3]

Mmolotsi

2nd house
Lesarwe
Moètshwe

3rd house
Nkudube
Phetwe [5]

4th house
Mma-Morwa
Segolabeng [6]

5th house
Moabi
Kobuane [7]

2nd house
Moetsenyane
Pooè-a-Mokgosi
Mmolotsi
Ntheko [9]

3rd house
Mangaka
Mokalake [10]
Mokalakane
Dijelwang
Sebe
Sebenyane

4th house
Sediko
Mokgōywe
Sebodu
Pulane
Malebo [11]
(Mma-Motsage)

5th house
Matlafela
Porogwane [16]
Nthekane
'Nthwe [12]
Bogosi
Seyamolodo
Seikgomeng [13]

6th house
Thoto
Sebitso
Sebitsonyane
Gabaediwe
Magoma
Tsonokwane
Rampatso

2nd house
Kgampane
Keutluile
Kgosiemang
Kgosane
Mayang
Shepherd
Makabetlwane (Mma-Lekgalagadi)
Ikalafeng
Mayako

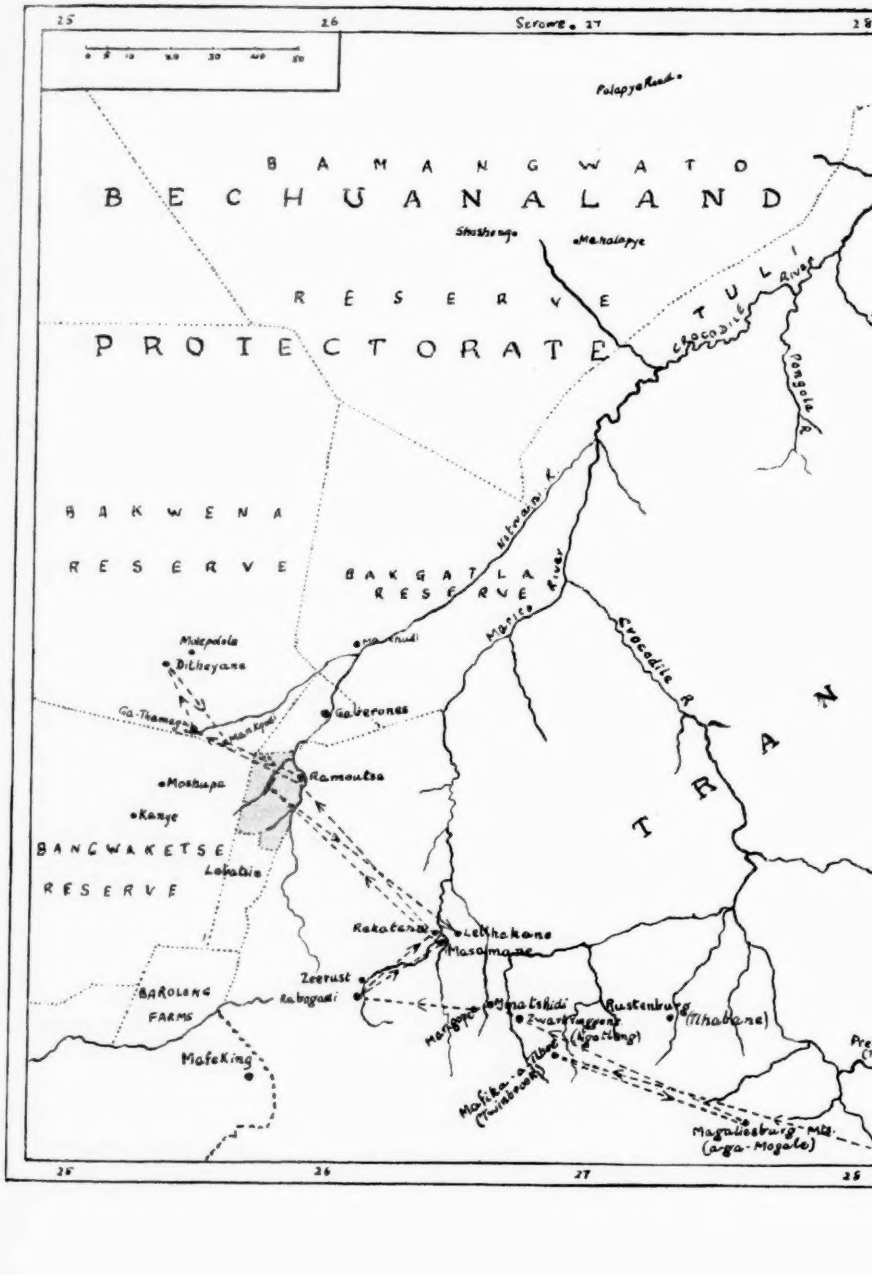
2nd house
Mothee
Ketswerebothata
Sefèmo
Sefèngwane
Peloakgosi

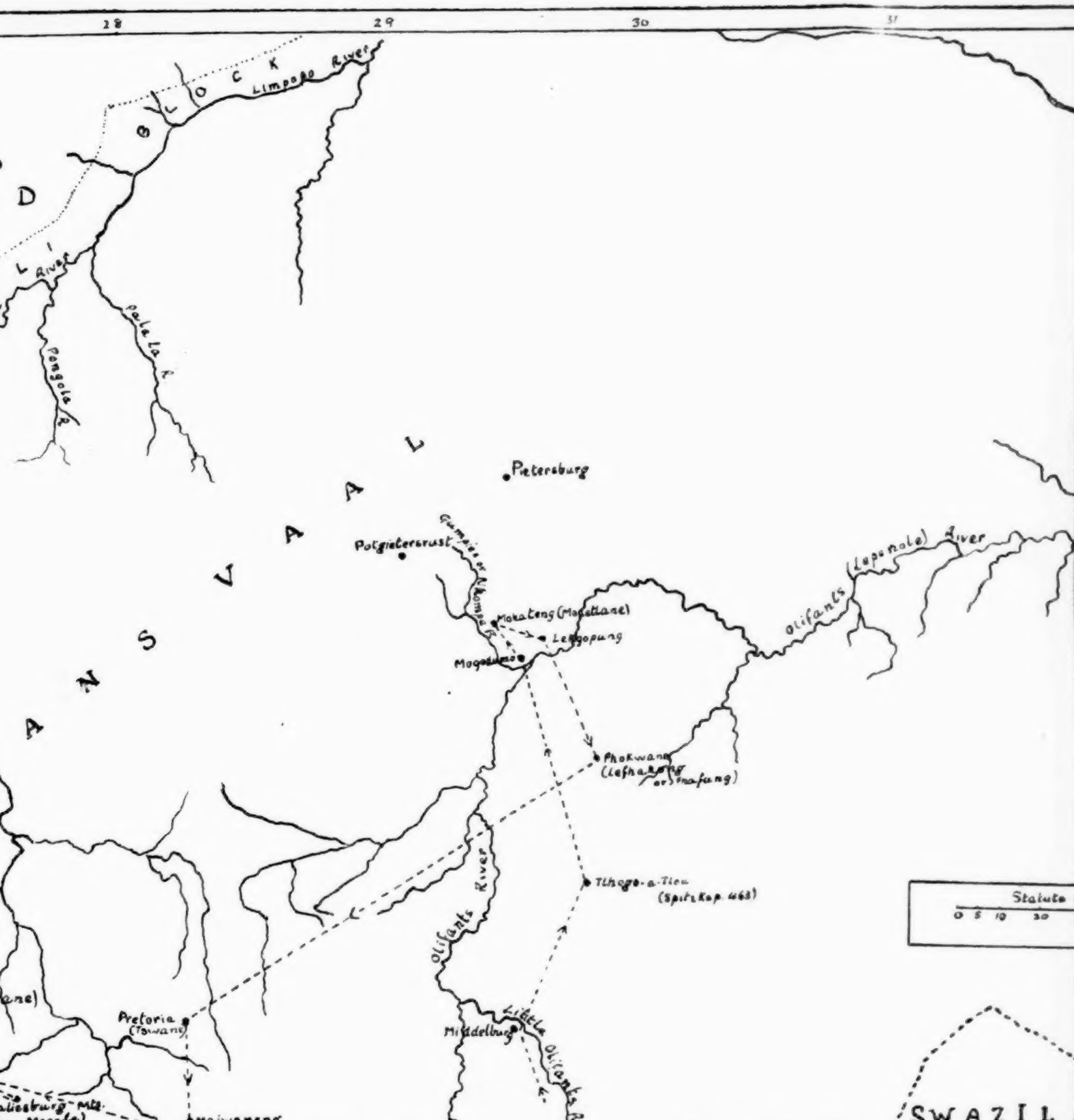
3rd house
Khutang
Lekote

Motswakhumo of Ntswe-le-tau, Bakwena Reserve.
[10] Died at Modipe.
[11] Living at Haartebeestfontein, Transvaal.
[12] Father of Headman Adolph Mokgosi.
[13] Mother of Headman Lokote Motladiile.
[14] Regent, 1906–1917.
[15] Heir to the Chieftainship. Born in 1922.
[16] Descendant (1935): Rantleru Mothibi.
[17] Mother of Headman Kealeboga Moagi.

Names in red signify females.
Names underlined thus ——— = alive in 1935.

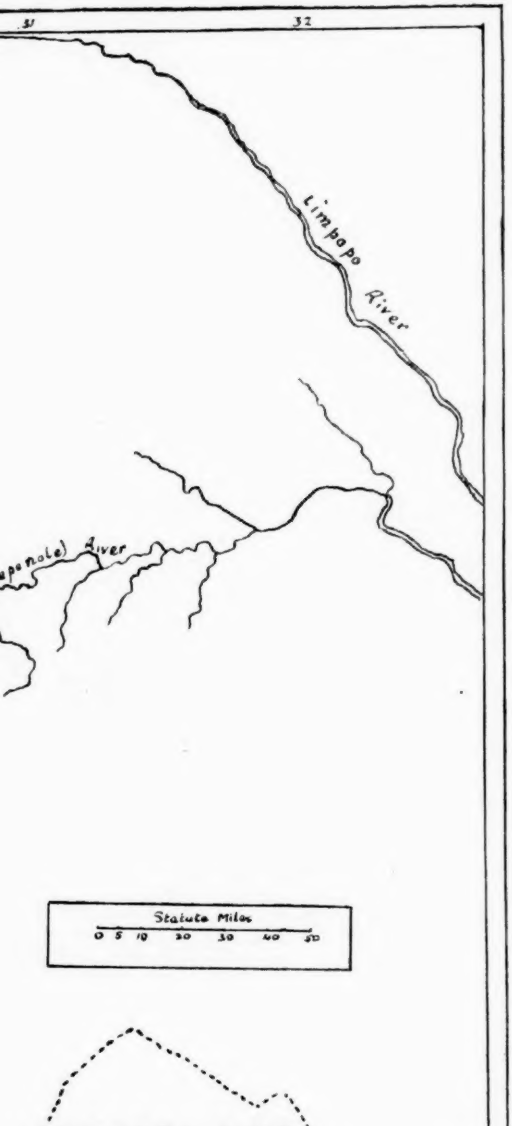
6th house	7th house	8th house	9th house	10th house
Thoto	Motsetselele	Mmamokae	Lekgoane	Mmaphare
Sebitso	Moilamashi	Seposengwe	Siitiso [17]	Monnaamere
ebitsonyane	Selotlegeng	Kebarebotse	Mmanape	Mogopa
Gabaediwe	Morea kgotla			Ratsoku
Magoma				Rannōgō
Tsonokwane				
Rampatso				


Serowe
Palapye Road
BAMANGWATO
BECHUANALAND
Shoshong
Mahalapye
RESERVE
PROTECTORATE
TULI
CROCODILE River
Pongola R.
BAKWENA
RESERVE
BAKGATLA
RESERVE
Notwani R.
Marico River
Crocodile R.
Molepolole
Ditheyane
Ga-Thamaga
Gaberones
Ramoutsa
Moshupa
Kanye
BANGWAKETSE
RESERVE
Lobatsi
TRAN
Rakatena
Lekhakane
Masamane
Zeerust
Rabogadi
BAROLENG
FARMS
Mafeking
Rustenburg
(Thabane)
Magaliesburg Mts.
(aga-Mogale)



28
29
30
31
Limpopo River
River
Pongola R.
Palala R.
A N S V A A L
Pietersburg
Potgietersrust
Mokateng (Mogetlane)
Mogosumo
Phokwane
Tlhogo-a-Tlou
Olifants River
Olifants (Lepelole) River
Little Olifants R.
Middelburg
Pretoria
(Tswane)
Majwaneng
Nape Hill
Statute
SWAZIL
from Volksrust
(Tlhogo-a-Tlou)

from Volksrust
(Thogo-a-Tlou)



31
32
Limpopo River
River
Statute Miles
0 5 10 20 30 40 50
SWAZILAND
31
32

STUDIES IN DECIDUOUS FRUIT.

IV.—The Effects of Methods of Extraction on the Determination of Nitrogenous Fractions in the Pulp of the Kelsey Plum.

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Chemistry Department, University of Cape Town.

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Introduction.

Several methods are available for the extraction of nitrogenous compounds from plant tissue. The most common procedure is to carry out the extraction with water or alcohol. Some investigators also use the expressed juice of previously frozen material. Since it is not always possible to carry out immediate extraction and analysis, it is usual to preserve the samples by heat drying, freezing or preservation in alcohol.

References in literature indicate that the various methods of preservative treatment and extraction may greatly affect the results of analysis of the extracted nitrogenous compounds (1, 8, 9, 12, 14, 15, 16, 17). These effects vary, however, with the material used, and no general rule can therefore be laid down. Thus Chibnall (1) found that drying leaves of the Runner Bean at 60° C. entailed protein hydrolysis and caused an increase in ammonium salts, asparagine and amino acids. Thomas (15) found that drying leaves and new shoot growth of Winesap apple trees at 60° C. did not greatly change the proportions of total water-soluble nitrogen and non-protein nitrogen, and that changes in ammonia and amide nitrogen were not, except in the woody tissues, much greater than the errors of determination. Lincoln and Mulay (9) reported that drying leaves at 50° C. increased the extractable non-protein nitrogen, but that drying wood and bark at 50° C. was satisfactory and gave the same results as obtained on fresh material. In general, it appears that each plant tissue represents a separate problem, and that a careful preliminary study of the properties of the tissue is essential before extensive analytical work may be undertaken.

As a preliminary to a study of the nitrogenous metabolism of Kelsey plums, it was therefore decided to compare the effects of the different

methods of extraction on the distribution of the various nitrogenous fractions. From the experimental point of view expressed juice is the most convenient material to work with, as it requires no further concentration. Alcohol extraction is more convenient than water extraction, as the excess alcohol is easier and quicker to evaporate at low temperature than water. In addition, hot alcohol is useful for prompt inactivation of enzymes (12). The final alcoholic extract is easy to filter and gives a brilliantly clear filtrate, whilst water extracts and expressed juice contain colloidal particles which are troublesome and difficult to filter from the liquid.

For the purpose of this study, water extraction of the fresh tissue was taken as the standard method. The quantities estimated were total soluble, non-protein, amide, amino and ammonia nitrogen. The distribution of these nitrogenous fractions in the water extract was compared with those in solutions obtained by (*a*) extracting frozen tissue with 75 per cent. alcohol, (*b*) water extraction of previously heat-dried tissue, and (*c*) expressed juice.

Preparation of Extracts.

The sample, consisting of thirty to forty plums, was cut up finely by hand and mixed. The stones were discarded. Different portions of pulp were taken for the various extracts.

(a) *Water Extracts of Fresh Tissue.*—250 gm. of pulp was soaked in 200 ml. water for about fifteen minutes and then squeezed dry through several layers of muslin. This was repeated three times and the pulp was then finely macerated in a mortar with the aid of pure quartz sand. The finely ground pulp was washed several times and the process of maceration and washing repeated until the final volume of extract amounted to 2000 ml. It was estimated that about 60–70 per cent. of all the soluble matter was removed from the pulp in the preliminary soaking. The extract was filtered by suction through an asbestos pad, concentrated under vacuo and finally made up to 250 ml. It was again filtered, a few drops of toluene were added and the extract held at $-5°$ C. until required.

(b) *Water Extract of Desiccated Material.*—300 gm. of fresh pulp was kept in an oven at 100° C. for about fifteen minutes and was then dried for seventy-two hours in a ventilated oven at 50° C. The dried material was finely ground and stored in a sealed tube. The soluble nitrogen in the dried material was extracted with cold water in a manner similar to that described under (*a*).

(c) *Expressed Juice.*—The juice was obtained by pressing the fresh material in a fruit press. The liquid was then strained through muslin and filtered through an asbestos pad. It was found impossible to obtain a clear juice by the usual filtration methods. As a last resort Kieselguhr was tried. The addition of about five grams Kieselguhr (Merck's, cleaned with hydrochloric acid and calcined) to about 100 ml. of juice before filtration solved the problem and gave a brilliantly clear filtrate. Estima-

tions of soluble nitrogen showed no adsorption of nitrogenous compounds by the layer of Kieselguhr on the filter pad. A few drops of toluene were added to the clear juice and it was stored at $-5°$ C. until required.

(d) *Alcoholic Extract.*—Webster (18) has reported that appreciable deaminisation of the nitrogenous compounds occurs in alcoholic extracts if stored for any length of time. Hulme (4) has indicated that no significant enzymatic or chemical change is undergone by the nitrogenous constituents of ground apple tissue if stored for periods of up to two months at $-20°$ C. It was therefore decided, in the present study, not to store the alcoholic extracts but instead to store weighed amounts of fresh tissue at the lowest available temperature ($-10°$ C.) until the extraction could be performed. The frozen pulp was then quickly ground in a mortar and allowed to defrost in alcohol. Sufficient 95 per cent. alcohol was added to give a final concentration of 75 per cent. alcohol and the pulp was allowed to soak thus for an hour. The alcoholic extract was then filtered through several layers of muslin and again through a fine filter in a Buchner funnel. The soaking of the pulp in 75 per cent. alcohol was repeated about eight times. The alcohol was distilled off under vacuo and the water extract thus obtained made up to 250 ml., filtered and stored at $-5°$ C. until required.

Methods of Analysis.

(a) *Total Soluble Nitrogen.*—20 ml. of the extract was placed in a Kjeldahl flask and evaporated to dryness at 40° C. under reduced pressure. The digestion was carried out by Ranker's modification of Kjeldahl's method. The digest was made up to 100 ml., and 20 ml. (equivalent to 1·5–2·0 mg. nitrogen) was used for estimation of ammonia in a micro-distillation apparatus. The acid and alkali used were 0·02 normal. The compound methyl red and methylene blue indicator (7) employed gave a very sharp end point.

(b) *Non-protein Nitrogen.*—Soluble proteins were precipitated with colloidal ferric hydroxide as described by Thomas (13). Total non-protein nitrogen was then determined on aliquots of the filtrate as under (a).

(c) *Free Ammonia and Volatile Bases.*—5–10 ml. of extract (equivalent to about 0·5 mg. free ammonia nitrogen) was used per determination. The method employed was that of Pucher, Vickery and Leavenworth (11), using a borax-sodium hydroxide mixture in conjunction with a phosphate buffer solution. The liberated ammonia was distilled over in vacuo at 40° C. into 10 ml. N/50 H_2SO_4. Parnas and Heller's apparatus (10) as modified by Chibnall and Westall (2) was used. The distillation took twenty minutes.

(d) *Amide Nitrogen.*—This was estimated on 5 ml. of extract. The method of hydrolysis employed was as laid down by Vickery *et al* (17). The ammonia distillation was carried out as in (c).

(e) *Amino Nitrogen.*—The usual micro Van Slyke method gave uncertain and often obviously high results. This was traced to the colouring matter in the extract. The use of bichromate as suggested by Hulme (6) did not remove interfering substances. Sörensen's formol titration method (13) was found to give concordant and easily reproducible results and was the method finally adopted. As the solutions were usually quite highly coloured, a comparator method similar to that described by Cole (3) was

used. Care was taken to carry out the blank determination for acidity under the same conditions and to the same end-point as for the formol titration.

TABLE I.

THE EFFECT OF CLEARING WITH COLLOIDAL FERRIC HYDROXIDE UPON THE TOTAL SOLUBLE NITROGEN IN WATER EXTRACTS (W.E.), ALCOHOLIC EXTRACTS (A.E.), JUICE AND WATER EXTRACTS OF PREVIOUSLY DRIED TISSUE (D.W.) OF THE PULP OF KELSEY PLUMS.

All results in mgm. Nitrogen per 100 grams Fresh Weight.

Sample.	Average weight of fruit in sample.	Mgm. N before clearing with $Fe(OH)_3$.				Mgm. N after clearing with $Fe(OH)_3$.			
		W.E.	A.E.	Juice.	D.W.	W.E.	A.E.	Juice.	D.W.
	grams.								
a	1·98	116·8	108·4	..	..	102·0	..	..	..
b	6·92	83·3	85·2	86·1	85·1	57·6	..	58·0	80·1
c	10·5	75·6	74·4	75·3	75·3	54·0	70·6	64·5	74·4
d	13·6	86·2	79·2	85·1	..	74·5	75·8	83·7	..
e	16·7	77·1	77·9	81·7	..	74·5	76·9	78·6	..
f	32·0	59·3	56·2	56·0	..	58·9	54·1	55·1	..
g	28·1	47·7	49·9	56·5	..	47·2	49·2	53·9	..
h	48·4	42·1	42·0	46·5	..	42·0	42·0	44·7	..
i	58·3	44·4	43·3	44·3	..	44·4	..	..	..
Standard Deviation		3·45%	2·43%	0·99%	..	2·97%	2·28%	1·32%	..

DISCUSSION OF RESULTS.

(i) *The Effect of Clearing with Colloidal Ferric Hydroxide on the Soluble Nitrogen Value of the Various Extracts.*

From consideration of Hulme's work on apples (5) in which he states that proteins directly soluble in water or alcohol appear definitely to be absent from the apple fruit, it was thought unlikely that such proteins would be present in the plum. A series of determinations of soluble nitrogen before and after treatment with colloidal ferric hydroxide were nevertheless carried out on the various extracts of a series of plums varying in weight from 1·98 gm. to about 60 gm. The results are shown in Table I. Estimates of error for each determination were obtained by analysis of six sub-samples taken from one sample of pulp. The values so obtained are shown at the bottom of Table I.

Two points of interest emerge from Table I. Firstly, treatment with ferric hydroxide lowers significantly the soluble nitrogen value of water extracts (Samples *a*, *b*, *c*, *d*) and juices (Samples *b* and *c*) of very young fruit, but has no effect on that of larger-sized fruits (Samples *f*, *g*, *h*, *i*).* Secondly, colloidal ferric hydroxide has no significant effect on the soluble nitrogen value of alcoholic extracts or that of extracts of previously dried tissue. Admittedly the data submitted are insufficient to draw definite conclusions on this point, but they fit in with the conception of water-soluble proteins or complex intermediate products, which are precipitated by the colloidal iron, being present in the very young fruit. Such protein compounds are most probably insoluble in alcohol, but liable to be denatured by slow freezing to -10° C. or by drying at 50° C. Detailed analysis of Sample *a*, Table I, gave the following results expressed in mg. Nitrogen per 100 gm. of fresh weight:—

	Sol. N.	Non-protein N.	Ammonia N.	Amide N.	Amino N.	"Rest" N.
A.E.	108·4	..	24·9	28·8	45·6	9·1
W.E.	116·8	102·0	24·9	26·8	40·2	10·0

The difference between the non-protein nitrogen value of the water extract (W.E.) and the soluble nitrogen value of the alcoholic extract (A.E.) can here be wholly accounted for by a significant variation in amino nitrogen, a likely product of hydrolysis of proteins. It will also be shown below that drying of the pulp at 50° C. significantly alters the distribution of soluble nitrogenous compounds in the resulting extracts (Table IV). The above observations possibly explain why treatment with ferric hydroxide has resulted in a lowering of the soluble nitrogen value only in the water extracts and juice, for in the preparation of these there is the least likelihood of interference with unstable nitrogenous compounds. The whole question

* When comparing two sets of results, significant differences were calculated as follows:—

If $U = x \pm y$ and S = Standard deviation,

then $Su^2 = Sx^2 + Sy^2$.

Significant difference = 2S.

The following values were obtained for standard deviations of the differences between

Soluble nitrogen on water extract and alcoholic extracts: $\pm 4·22$ per cent.

" " " " juice: $\pm 3·59$ per cent.

Non-protein nitrogen on water extract and alcoholic extract: $\pm 3·73$ per cent.

" " " " juice: $\pm 3·24$ per cent.

needs further study, but it is suggested that for very young fruit it is preferable to estimate the various nitrogenous fractions on water extracts of fresh pulp.

TABLE II.

COMPARISON OF THE DISTRIBUTION OF NITROGENOUS COMPOUNDS IN WATER EXTRACTS (W.E.) AND ALCOHOLIC EXTRACTS (A.E.) OF PULP OF KELSEY PLUMS.

All results in mgm. Nitrogen per 100 grams Fresh Weight.

Sample.	Soluble N.		Ammonia N.		Amide N.		Amino N.	
	W.E.	A.E.	W.E.	A.E.	W.E.	A.E.	W.E.	A.E.
I .	42·0	42·0	2·53	2·39	18·1	17·4	..	..
II .	48·0	50·3	2·38	2·53	9·5	9·7	28·8	29·0
III .	51·6	51·2	2·32	2·42	10·7	10·9	28·9	30·6
IV .	76·8	74·7	3·86	3·71	27·1	27·7	27·2	27·0
V .	89·0	84·7	24·9	25·9	24·6	23·6	17·8	18·3
VI .	94·1	91·8	27·8	27·1	23·5	23·6	..	..
VII .	99·1	97·3	20·7	21·2	28·4	27·1	28·0	27·2
VIII .	101·7	98·2	14·7	14·1	30·8	30·0	31·7	31·5
IX .	66·8	66·6	..	..	..	..	..	..
X .	47·7	49·8	..	..	..	..	..	..
XI .	44·4	43·3	..	..	..	..	..	..

(ii) *Comparison of Nitrogenous Compounds in Alcohol and Water Extracts of Almost Mature Plums.*

In order to gauge the magnitude of differences between nitrogen values on alcoholic extracts and those obtained from water extracts, a series of determinations were carried out, the results of which are given in Table II. Since it appears from the results in Table I that in extracts of mature fruit the figures for total soluble nitrogen and non-protein nitrogen agree very well, treatment with colloidal ferric hydroxide has been dispensed with in the analyses of samples shown in Table II. The agreement between the soluble nitrogen figures for alcoholic and water extracts is satisfactory, and the differences are never greater than 4·8 per cent. of the water-extract value. This is not much larger than the estimated standard deviation. The agreement between the various values for ammonia, amide and amino nitrogen is also excellent. It may be concluded, therefore, that 75 per cent. alcohol extracts nitrogenous compounds from the mature plum in the same proportion and in equal amounts to that of water.

TABLE III.

COMPARISON OF THE DISTRIBUTION OF NITROGENOUS COMPOUNDS IN ALCOHOLIC EXTRACTS (A.E.) AND JUICE OF PULP OF KELSEY PLUMS.
All results in mgm. Nitrogen per 100 grams Fresh Weight.

Sample.	Soluble N.		Ammonia N.		Amide N.		Amino N.	
	A.E.	Juice.	A.E.	Juice.	A.E.	Juice.	A.E.	Juice.
XII	83·6	85·9	7·95	7·18	28·8	29·0	28·6	39·0
XIII	77·1	81·0	4·03	3·74	26·7	29·1	28·3	33·9
XIV	70·1	77·3	3·15	2·65	23·9	26·9	25·2	27·8
XV	70·0	74·3	1·93	1·92	24·3	26·2	26·8	29·9
XVI	75·0	71·6	2·39	1·62	25·1	24·8	27·0	30·2
XVII	51·2	48·6	2·13	2·42	9·90	10·2	28·5	28·6
XVIII	77·9	81·7	..	..	..	..	..	..
XIX	56·2	56·0	..	..	..	..	..	..
I	42·0	46·5	..	..	..	..	..	..
X	49·9	56·5	..	..	..	..	..	..
XI	43·3	44·3	..	..	..	..	..	..

(iii) *Comparison of Nitrogen Compounds in Juice and in Alcoholic Extracts.*

The estimations for nitrogen carried out on juice were calculated back to fresh weight basis by the formula

$$W = \frac{C(100-R)}{S} \text{ mgm.}$$

where W = mgm. nitrogen in 100 gm. pulp,
C = ,, ,, 100 ml. juice,
R = alcohol insoluble residue as percentage fresh weight,
S = specific gravity of juice.

This mode of calculation is known to hold for acidity and sugar determinations on juice, and the good agreement obtained (in most cases) for the values of nitrogen estimated on alcohol extracts and juice (Table III) indicates that the formula holds for nitrogen determinations as well.

From the results in Table III it may be concluded that, in general, juice can be expected to give values for nitrogen in good agreement with those on alcoholic extracts. Occasionally serious discrepancies have been observed, as, for instance, in Samples I, X, XII and XIV. The amino nitrogen values on juice are usually somewhat high. In the absence of some sort of check, estimations on juice are thus liable to be somewhat uncertain.

TABLE IV.

COMPARISON OF THE DISTRIBUTION OF NITROGENOUS COMPOUNDS IN ALCOHOLIC EXTRACTS (A.E.) AND WATER EXTRACTS OF DRIED TISSUE (D.W.) OF PULP OF KELSEY PLUMS.

All results in mgm. Nitrogen per 100 grams Fresh Weight.

Sample.	Soluble N.		Ammonia N.		Amide N.		Amino N.	
	A.E.	D.W.	A.E.	D.W.	A.E.	D.W.	A.E.	D.W.
IV . .	74·7	79·1	3·71	2·36	27·7	23·8	27·0	15·6
VIII .	98·2	98·0	14·1	3·62	30·0	27·8	31·5	23·9
XII .	83·6	92·2	7·95	2·82	28·8	27·9	28·6	22·3
XIII .	77·1	76·1	4·03	2·47	26·7	17·3	28·3	9·87
XX .	41·0	41·7	2·62	2·03	10·1	9·52	21·0	15·1
XXI .	50·3	51·0	1·99	1·91	..	..	..	..

(iv) *Comparison of the Nitrogen Content in Alcoholic Extracts and in Water Extracts of Previously Dried Material.*

The results for these comparisons are shown in Table IV. Except for Sample XII the values for soluble nitrogen on the dry-weight extracts are in good agreement with those of the alcoholic extracts. But the values for ammonia, amide and amino nitrogen are consistently low and indicate that drying at 50° C. completely alters the distribution of nitrogenous fractions in the final extracts. The use of dried tissue for the determination of nitrogenous fractions in Kelsey plums is therefore quite inadmissible.

SUMMARY AND CONCLUSIONS.

1. The methods of preservation and extraction may greatly affect the results of analysis of nitrogen fractions in plant tissue. These effects vary with the material used.

2. Determinations were carried out of soluble non-protein, ammonia, amide and amino nitrogen in various extracts of the pulp of Kelsey plums.

3. The methods of preservation and extraction of the tissue were as follows: (*a*) Water extraction of fresh tissue, (*b*) alcohol extraction of frozen tissue stored at −10° C., (*c*) expressed juice, (*d*) water extraction of tissue previously dried at 50° C. Details of methods of preparation of the samples and analysis of the various nitrogen extracts are given.

4. Results are given which suggest that in very young fruit soluble proteins might be present which are precipitated by colloidal ferric hydroxide in the water extracts and juices, but are altered by freezing or by drying the tissue. It is therefore suggested that for very young fruit it is preferable to estimate nitrogenous fractions on water extracts of fresh tissue.

5. It is concluded that 75 per cent. alcohol and water extract equal amounts of nitrogenous compounds from the pulp of mature plums.

6. Estimations on juice are occasionally liable to give anomalous results.

7. The use of dried tissue for estimations of nitrogenous compounds in plums gives low values for ammonia, amide and amino nitrogen.

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STUDIES IN DECIDUOUS FRUIT.

V.—Preliminary Observations on the Relationship between Nitrogenous Metabolism and Internal Breakdown of Kelsey Plums in Cold Store.

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(With four Text-figures.)

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Introduction.

The investigation described in this paper has been initiated as a further attempt to find some major chemical factor connected with the occurrence of internal browning of Kelsey plums (*Prunus salicina*) in storage. The main features of this malady, its extent and importance, have been discussed in various publications (1, 2, 5, 6). In agreement with observations on fruit made elsewhere (15), it has so far been found difficult to establish any definite relationship between the changes in sugars and acid content of the plums and their actual behaviour in cold store (7). It has been observed, however, that during the growth period of the fruit definite relationships exist between the intake of nitrogen and the mineral constituents of the fruit (4), and that the keeping quality of the plums, picked at the same stage of ripeness as judged by colour, is in some way connected with their nitrogen content at time of gathering. This is illustrated in Table I, where the general variation in the keeping quality of Kelsey plums during the last three years is shown alongside the average nitrogen content of the fruit.

It thus appears that an inquiry into the changes of the nitrogenous substances in the plum during storage might prove very profitable, especially as nitrogen content has been found to be related to the amount of potassium and phosphate in the plum.* Nitrogen content, therefore, reflects the

* Cohen (4) has shown that in the Kelsey plum there is very nearly a linear relationship between the concentrations of phosphates and potassium and between potassium and nitrogen in the fruit practically throughout the entire growth period. He found that the constants of these linear relationships varied from season to season and farm

cultural history of the fruit. Furthermore, it has been observed that the appearance of colour in the Kelsey plum is related to some extent to the percentage of nitrogen in the fruit.* Low nitrogen fruit colours earlier than high nitrogen fruit.

Any relationship between nitrogen content and breakdown in store would then serve to explain why the keeping quality of fruit picked at the same stage of colour and stored under similar conditions differs so greatly with season and orchard.

Table I.

Nitrogen Content of Kelsey Plums and Keeping Quality of the Fruit in Store.

Orchard.	Season.	Nitrogen content mg. in 100 grams of fresh weight.	Keeping quality in store.
A	1933–34	99·6	Fair.
	1934–35	115·0	Good.
	1935–36	84·0	Very poor.
	1935–36 †	112·2	Very good.
B	1933–34	98·6	Poor.
	1934–35	128·6	Good.
C	1933–34	99·0	Poor.
	1934–35	133·0	Very good.
	1935–36	127·7	Very good.
D	1933–34	113·6	Good.

Little information is available about the nitrogenous metabolism of fruit. Pilling and Pearsall (13) studied nitrogenous changes in Bramley Seedling and Newton apples during storage, and found evidence of decided

to farm, and suggested that, these constants reflect the effects of environment and cultural treatment. Owen (12) also found a direct relationship between the potash and phosphate content of the tomato. The important implication arising out of these results is that nitrogen content is a measure of the intake by the fruit of some of the most important mineral components of the ash.

* In February 1926 it was observed that in two different orchards fruit from high nitrogen-treated plots developed colour about a fortnight later than those from low nitrogen plots. Analyses of representative samples of the fruit picked at the same colour stage gave the following results (nitrogen as percentage fresh weight):—

Early ripening fruit .	·0677 per cent. N.	·0733 per cent. N.
Late ,, ,, .	·1120 per cent. N.	·1357 per cent. N.

† This is a sample of plums taken from four trees injected by the method of Roach (14) with urea and potassium hydrogen phosphate.

changes in the protein and "rest" nitrogen fractions. They suggested that internal breakdown of the apple may be associated with the development of certain critical concentrations of "rest" nitrogen. Hulme (10) used samples of Bramley Seedling apples from ringed and unringed trees. During storage at 1° C. he found a significant increase in protein nitrogen and a corresponding decrease of soluble nitrogen (and its nitrogen fractions), but no relationship between nitrogenous changes and low temperature breakdown of the apple. In a later paper (11) more promising results were obtained by the discovery that the amino acids reach a maximal concentration in the tissues of the apple prior to the development of low temperature breakdown in store.

The aim of the present investigation has been to discover whether any changes in the protein and non-protein fractions take place in the Kelsey plum when stored at 35° F., and to what extent such changes are related to the occurrence of internal browning in the fruit.

Material.

In a previous publication (6) it has been shown that the occurrence of internal browning in the Kelsey plum stored at 35° F. is greatly influenced by the stage of its maturity * at picking-time. This observation has since been confirmed by observations made in the years 1935, 1936, and 1937. For the purpose of this study it was therefore decided to pick two series of samples: one—the G series—when the fruit was still green and immature and highly susceptible to internal browning, and another—the R series—when the fruit was quite ripe and from previous experience might be expected to keep well and show no browning in storage.

The plums for the G series were picked on 5th February 1936, and were of an even green colour. The R-series fruit was picked on 24th February, and the plums had about 50 per cent. of their surface speckled with red colour and were in an advanced stage of maturity. The plums were all collected from the same row of twelve trees. The trees were ten years old, and had received identically the same fertiliser treatment since planting. They were very even both in vigour and in the size of the crop they bore.

On picking, the fruit was graded into various sizes and all plums showing the slightest blemish were discarded. Twenty-four samples of forty plums were chosen for each series, all samples containing the same number of

* By "maturity" is meant the stage of the fruit on its developmental curve of growth. For plums picked in the same season from the same trees, in the same orchard, and receiving the same cultural treatment, various stages of "maturity" can be quite well gauged by the extent of yellowing of the ground colour of the plum and the development of red pigmentation.

fruits from the various grades. The samples were then weighed, and three of each series were immediately analysed and served as a gauge of the sampling error of the various determinations. Fifteen samples of each series were placed at 35° F., three samples at 50° F., and the remaining three samples kept at 70° F.

Methods of Analysis.

On removal from store the sample was reweighed to determine loss of moisture and to allow the calculation of results on the original fresh-weight basis. The flesh of the fruit was then cut up finely by hand, well mixed and portioned for alcoholic extraction and dry-weight determination. (The stones were discarded.) The method of extraction has been described in detail in a previous publication (9), where it was shown that for mature Kelsey plums determinations of total soluble nitrogen, amide, amino, and ammonia nitrogen are in excellent agreement with results obtained on water extracts previously cleared with colloidal ferric hydroxide for precipitation of proteins. Total soluble nitrogen in alcoholic extracts thus represents non-protein nitrogen only. Total nitrogen was determined on the dried sample by Ranker's method (8). Non-protein nitrogen, ammonia, amide and amino nitrogen were determined as in (9), except that a 10 per cent. suspension of magnesium oxide was used for the distillation of ammonia instead of a buffered borax-sodium hydroxide mixture. Sugars and acidity were estimated on fractions of the alcoholic extracts (8). "Rest" nitrogen was computed by subtracting the sum of ammonia, amide and amino nitrogen from that of soluble nitrogen. "Rest" nitrogen thus represents all soluble nitrogenous compounds of higher complexity than amino acids or asparagine. Protein nitrogen was obtained by difference between total nitrogen and non-protein nitrogen. Chibnall and Westall's method (3) for differentiating between glutamine and asparagine was used to determine whether or not glutamine was present in several of the extracts. No glutaminé appeared to be present. Assuming that all amide nitrogen is present in the form of asparagine, amide and amino nitrogen were then expressed as asparagine and amino-acid nitrogen: thus asparagine $N = 2 \times$ amide N, and amino acid $N =$ amino $N -$ amide N.

Presentation of Results.

The results of analysis of fruit kept at 35° F. are given in Tables III and IV. In spite of the careful selection of the samples the total nitrogen content varied considerably. Thus for the G series the maximum deviation from the mean of 82·4 mgm. per 100 gram of original fresh weight is

8·6 mgm. It was therefore decided to express the results as percentage of total nitrogen or as percentage of soluble nitrogen. The analyses of the three initial samples for each set are given in Table II. At the bottom of the table are shown values for standard deviations calculated from these results.

TABLE II.

All results as percentage of Total Nitrogen.

Sample.	Total N mgm./100 grams fresh weight.	Soluble N.	Ammonia N.	Amide N.	Amino N.	Rest N.
G, A	87·8	55·0	2·75	20·1	24·4	7·8
B	78·7	59·5	3·29	20·4	23·7	12·1
C	81·8	55·8	3·39	20·2	23·7	8·5
R, A	73·0	51·9	4·05	14·9	15·6	17·4
B	80·5	50·3	3·90	15·9	15·1	15·4
C	77·9	49·0	3·40	14·3	16·4	14·9
Standard deviation	G	±2·40%	±0·34%	±0·16%	±0·41%	±2·38 %
	R	±1·49%	±0·34%	±0·81%	±0·66%	±1·32 %

Analysis of samples of plums immediately after gathering. G, A B C, and R, A B C, represent two sets of initial samples for the G series and R series respectively. Standard deviations were calculated by the formula

$$\text{S.D.} = \sqrt{\frac{\Sigma v^2}{n-1}},$$

where v = deviation from mean
and n = number of observations.

Since it is quite a reasonable assumption that the changes in the nitrogenous fractions in the fruit are continuous, smooth curves have been fitted to the experimental points and are shown in figs. 3 and 4. These smooth curves indicate only the average trend of the reactions as shown by the experimental points, and no greater importance has been attached to them in the course of the discussion that follows. The constants of the equations representing these curves are shown in Table V.

[TABLES.

TABLE III.

CHANGES IN THE NITROGENOUS FRACTIONS OF KELSEY PLUMS DURING STORAGE AT 35° F.
(G SERIES: UNRIPE PLUMS.)

All results in mgm. N per 100 grams Original Fresh Weight.

Days in store.		0.	12.	21.	30.	38.	48.	55.	63.	72.	83.	98.	116.	120.	137.	161.
Loss of weight as per cent. original fresh weight		0	2·16	3·45	4·53	5·62	7·48	7·35	9·37	9·90	10·2	10·4	15·1	15·9	19·2	21·2
Total nitrogen		82·8	79·0	73·8	86·2	80·5	87·7	91·4	84·8	79·0	86·9	88·9	82·5	82·3	85·8	75·5
Non-protein N		47·1	47·4	45·7	56·5	55·5	57·4	60·1	58·5	54·8	60·4	72·8	63·8	56·3	60·4	53·4
Ammonia N		2·60	2·33	2·05	2·83	2·58	2·71	3·04	2·29	2·35	2·04	2·76	3·18	3·32	2·21	2·31
Amide N		16·8	17·4	15·0	19·4	19·1	19·3	19·1	17·9	17·4	19·0	22·3	18·1	14·9	14·7	14·1
Amino N		19·9	19·4	18·8	..	19·9	25·1	25·6	28·1	23·4	28·0	31·5	26·8	25·2	29·5	26·8
Rest N		7·8	8·2	9·8	..	13·4	10·3	12·4	10·2	11·6	12·9	16·2	15·7	12·8	14·0	10·2
Protein N per cent. total N		43·2	40·0	38·1	34·5	32·1	35·0	34·3	31·1	30·7	30·6	19·2	22·7	31·7	29·6	29·3
Non-protein N per cent. total N		56·8	60·0	61·9	65·5	67·9	65·0	65·7	68·9	69·3	69·4	81·8	77·3	68·3	79·4	70·7
Ammonia N	Per cent. total N	3·14	2·95	2·80	3·28	3·21	3·09	3·32	2·70	2·97	2·34	3·11	3·85	4·03	2·58	3·06
	Per cent. non-protein N	5·52	4·30	4·50	5·00	4·65	4·73	5·06	3·92	4·30	3·37	3·80	5·00	5·90	3·66	4·33
Asparagine N	Per cent. total N	40·5	44·2	40·6	45·0	47·4	44·0	41·7	42·3	44·0	44·2	50·2	43·8	36·3	34·2	37·4
	Per cent. non-protein N	71·2	65·0	65·6	68·8	68·8	67·2	63·4	61·2	63·6	63·0	61·2	56·8	53·2	48·6	52·6
Amino-acid N	Per cent. total N	3·8	2·4	5·2	..	1·0	6·6	7·2	12·0	7·6	10·1	10·4	10·6	12·4	17·3	16·8
	Per cent. non-protein N	6·7	3·6	8·4	..	1·4	10·1	10·9	17·4	10·9	14·8	12·7	13·6	18·2	24·5	23·9
Rest N	Per cent. total N	9·4	10·5	13·3	..	16·7	11·7	13·6	12·0	14·7	14·8	18·3	19·1	15·6	16·3	13·5
	Per cent. non-protein N	16·6	17·3	21·4	..	24·2	18·0	20·7	17·5	21·2	21·4	22·2	24·6	22·8	23·2	19·1

TABLE IV.

CHANGES IN THE NITROGENOUS FRACTIONS OF KELSEY PLUMS STORED AT 35° F.
(R SERIES: RIPE PLUMS.)

All results in mgm. N per 100 grams Original Fresh Weight.

Days in store.		0.	10.	20.	29.	37.	45.	54.	64.	75.	87.	99.	110.	120.	129.	142.	157.
Loss of weight as per cent. original fresh weight.		0	2·64	3·51	4·52	7·38	7·09	9·66	12·4	14·1	16·4	16·3	18·1	23·4	23·6	28·7	32·0
Total nitrogen		77·3	85·0	80·2	78·6	80·7	77·4	78·0	79·8	83·3	78·8	77·5	80·0	79·6	81·5	74·5	79·0
Non-protein N		38·9	42·7	47·0	45·7	54·1	50·7	52·6	54·9	56·2	56·0	52·4	51·2	51·8	55·1	49·4	50·3
Ammonia N		2·92	2·86	3·05	2·79	3·10	2·43	2·65	2·31	1·98	2·40	2·63	2·13	1·98	2·82	2·16	1·99
Amide N		11·6	12·0	13·7	12·0	13·6	11·9	12·4	12·5	12·3	13·0	12·7	9·9	11·9	10·9	10·1	10·8
Amino N		12·1	13·4	14·2	16·7	23·6	..	25·9	27·2	30·5	29·6	28·2	28·5	28·7	30·6	27·9	30·2
Rest N		12·3	14·4	16·1	14·3	13·7	..	11·7	12·9	18·2	11·0	8·9	10·7	9·2	10·8	9·3	7·4
Protein N per cent. total N		49·6	49·8	41·4	41·9	33·0	34·5	82·6	31·3	32·5	28·9	32·4	36·0	34·8	33·4	33·7	36·3
Non-protein N per cent. total N		50·4	50·2	58·6	58·1	67·0	65·5	67·4	68·7	67·5	71·1	67·6	64·0	65·2	67·6	66·3	63·7
Ammonia N	Per cent. total N	3·78	3·36	3·80	3·55	3·84	3·14	3·39	2·89	2·38	3·05	3·40	2·66	2·50	3·44	2·90	2·52
	Per cent. non-protein N	7·50	6·70	6·50	6·10	5·74	4·80	5·04	4·21	3·52	4·28	5·02	4·16	3·82	5·12	4·37	3·96
Asparagine N	Per cent. total N	30·0	28·3	34·1	30·5	33·8	30·6	31·8	31·2	29·4	33·0	32·6	24·3	30·0	26·8	27·0	27·2
	Per cent. non-protein N	60·0	56·2	58·2	52·6	50·4	46·8	47·2	45·6	43·6	46·4	48·4	38·0	46·0	39·6	40·6	42·8
Amino-acid N	Per cent. total N	0·6	1·7	0·7	6·0	12·40	..	17·3	18·4	21·9	21·1	20·1	24·5	21·1	24·2	23·9	24·6
	Per cent. non-protein N	1·2	3·4	2·1	10·2	18·50	..	25·7	26·8	32·6	29·6	29·6	36·7	32·4	35·8	36·2	38·6
Rest N	Per cent. total N	15·9	16·9	20·1	18·2	17·0	..	14·9	16·1	13·6	14·0	11·5	13·4	11·6	13·3	12·5	9·4
	Per cent. non-protein N	31·0	33·7	34·2	31·4	25·3	..	22·2	23·4	20·2	19·7	17·0	20·9	17·8	19·6	18·5	14·0

TABLE V.

Constants of Equations of Curves shown in figs. 3 and 4.

A. Equations of type $y=at \pm b$.

Curve.	Constants.	
	a.	*b.*
G. Asparagine N	·01739	42·57
G. Amino acid N	·09188	2·092
G. Rest N	·04831	11·19
G. Ammonia N	·0003536	3·005
R. Asparagine N	·01679	30·60
R. Rest N	– ·04898	18·26
R. Ammonia N	– ·006524	3·644

B. Equations of the type $=at_2 \pm bt \pm c$.

Curve.	Constants.		
	a.	*b.*	*c.*
G. Soluble N as per cent. total N	– ·0009187	·2236	57·83
R. ,, ,, ,,	– ·002471	·4885	47·13
R. Amino acid N . . .	– ·001506	·3940	– 1·950

DISCUSSION OF RESULTS.

Figs. 2, 3, and 4 summarise the chemical changes which take place in the nitrogenous fractions of both green and ripe fruit stored at 35° F. The most important changes are breakdown of proteins and accumulation of amino-acid nitrogen and "rest" nitrogen. The two series are similar in that both show considerable non-protein accumulation in the first ninety days of storage, but they differ significantly in their paths of protein breakdown.

Protein Breakdown.—Before discussing the possible significance of protein hydrolysis in stored fruit, it is perhaps advisable to consider briefly the changes in the relative proportions of non-protein and protein nitrogen in the growing plum. This is shown in fig. 1.* Initially there is a rapid

* Fig. 1 is based on data given in Table I of a previous publication (9).

rise in the non-protein fraction from 30 to 50 per cent. of the total nitrogen, but during the two months prior to the gathering-time of the fruit little alteration in the proportions of these nitrogenous fractions takes place. During growth, therefore, a state of equilibrium appears to

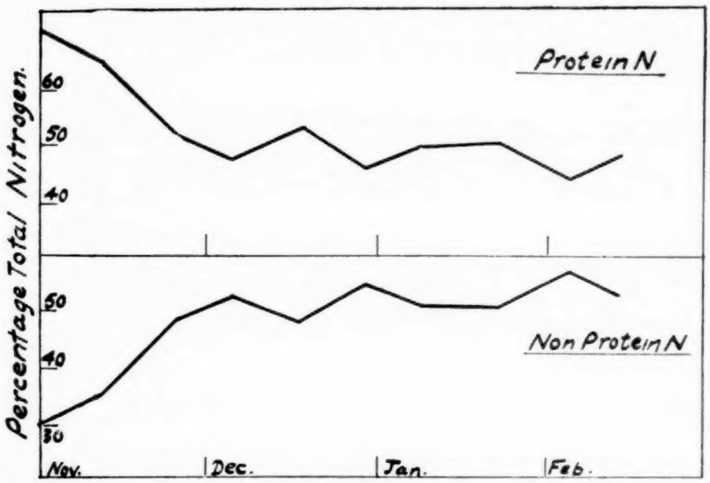

Fig. 1.—Changes in the protein N and non-protein N fractions in the pulp of Kelsey plums during their growth in the 1935–36 season.

be reached between the rates of accumulation of protein and non-protein nitrogen in the fruit.

After gathering the fruit, rapid breakdown of protein nitrogen takes place early in the plum's storage life (fig. 2). A possible explanation of this might be that the picking of the fruit upsets the equilibrium between the nitrogenous compounds in the plum established during its growth. Rapid breakdown of protein then takes place until equilibrium is again restored. The significant increase in protein nitrogen in the fruit of the R series after the ninetieth day is distinct evidence that synthesis of protein * also takes place during the storage life of the plum (figs. 2 and 4).

On the other hand, the rate of protein breakdown appears to be connected with the ability of the fruit to ripen properly. Thus, four samples of fruit from orchard C, analysed a week after picking, showed 71·6, 73·7, 74·6, and 70·7 per cent. of their total nitrogen content in the form of non-protein nitrogen. This fruit showed excellent keeping quality in store at

* The observation by Hulme (10) that synthesis of protein takes place during storage of apples is of interest here.

35° F., and, after being kept for a sufficient time, ripened to a full red colour. Again, the R-series fruit ripened quite well in store at 35° F., and showed a rate of protein hydrolysis more than twice as great as that observed in the fruit of the G series, which did not ripen well at all. Another

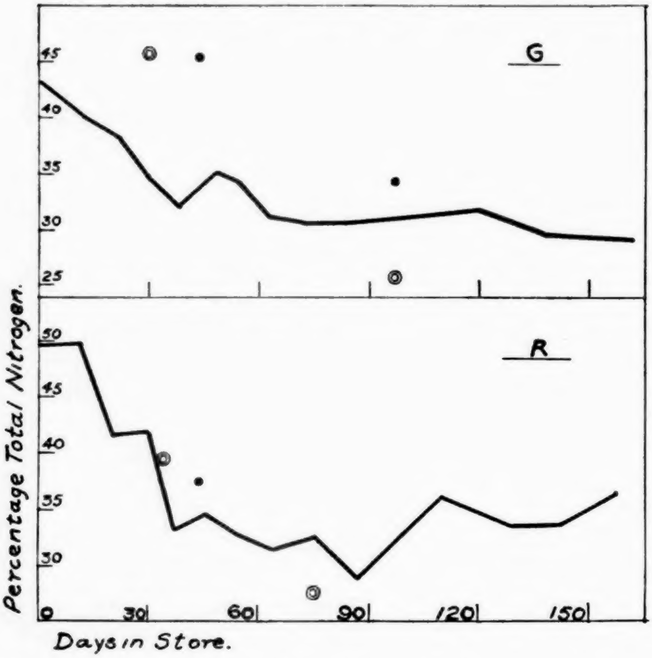

Fig. 2.—Changes in the protein N fraction of Kelsey plums stored at 35° F.

G = Green plums. R = Ripe plums.

Black circles represent fruit stored at 50° F.
Double " " " 70° F.

explanation that can therefore be advanced is that protein hydrolysis is connected with the process essential for the ripening of plums at low temperatures. In this connection it is interesting to note that, except in two cases,* non-protein nitrogen never exceeded 75 per cent. of the total nitrogen. Even in fruit stored for eighty to one hundred days at 70° F. and also at 50° F., after which time the plums were almost completely

* Samples 11 and 12 of the G series, Table III. These two samples give values for non-protein nitrogen which are obviously high and quite outside the general trend of results.

"bladdery" in the case of R-series plums and "watery" in the case of G-series plums (especially when stored at 50° F.), protein nitrogen formed not less than 25 per cent. of the total nitrogen. Possibly, then, some protein fraction always remained unchanged in the fruit. In that case the observed protein breakdown in stored plums might have been confined to reserve proteins, which can be expected to be present in a storage organ such as a fruit, whilst the proteins forming the protoplasmic mass of the living cells remained largely unaffected.

The Path of Protein Breakdown.—The general course of the changes of ammonia, amino, "rest," and asparagine nitrogen in fruit stored at 35° F. is shown in figs. 3 and 4. In order to estimate the relationship between these products of protein breakdown, a "balance sheet" shown in Table VI has been constructed from the calculated equations of curves fitted to the experimental points.

For convenience of discussion the storage life of the fruit can be divided into two distinct periods: during the first period of 0–90 days protein hydrolysis takes place in fruit of both the G and R series. Amino-acid nitrogen accumulates in all fruit, but whilst "rest" nitrogen rapidly breaks down in the R plums, it increases in plums of the G series. Asparagine nitrogen shows a tendency to accumulate during this period, but the total increase (1·50 per cent.) is not significant. Nor is there a significant rise in ammonia N. These results are summarised quantitatively in Table VI, and one possible deduction is that the path of protein breakdown in the plum is: Protein N $\longrightarrow$ Rest N $\longrightarrow$ Amino acid N. Since no ammonia or asparagine is accumulated, it appears that protein hydrolysis is arrested at the amino-acid stage and does not lead to deamination.

Table VI.

Relationship between Nitrogen Fractions during Storage.

The given figures relate to the increase or decrease as percentage of Total Nitrogen.

Series.	Days in store.	Protein N.	Amino-acid N.	Asparagine N.	Rest N.	Ammonia N.
R	0– 90	−19·51	+20·71	+1·51	−2·00	−0·69
R	90–150	+ 5·60	+ 3·00	−5·61	−2·94	−0·39
R	0–150	−13·91	+23·71	−4·10	−4·94	−1·08
G	0– 90	−13·70	+ 8·27	+1·57	+4·35	0·0
G	90–150	0·0	+ 5·51	−5·08	−0·77	0·0
G	0–150	−13·70	+13·78	−3·51	+3·58	0·0

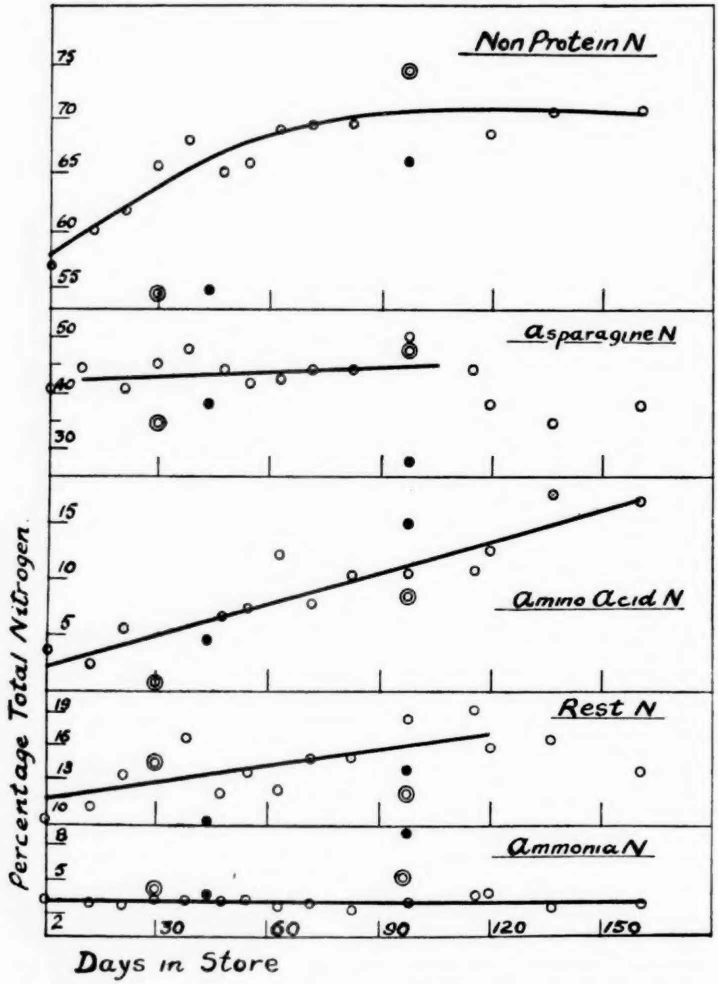

FIG. 3.—Changes in the nitrogenous fractions of the G-series fruit stored at 35° F. Equations of the fitted smooth curves are given in Table V.

Black circles represent samples of plums stored at 50° F.
Double ,, ,, ,, ,, 70° F.

During the second period of storage at 35° F. (90–150 days) a significant rise in protein N takes place in the R-series fruit; this rise is not observed in the G series. At the same time a significant drop in asparagine N takes

place. In the G series it is almost completely accounted for by a corresponding rise in amino-acid N, but in the R series the drop in asparagine N is much larger than the increase in amino-acid N and is accompanied by protein regeneration. It is thus possible that part of the nitrogen derived from asparagine breakdown is used for protein synthesis.

In this connection it is of interest to note that in plums stored at 50° F. or 70° F. decrease in asparagine is always accompanied by ammonia accumulation in the pulp of the fruit, indicating that the source of ammonia is asparagine (Table VII). In fruit stored at 35° C., on the other hand, asparagine breakdown does not yield an increase in ammonia N. Under this condition the ammonia N obtained from asparagine breakdown presumably forms amino acids, or even more complex compounds.

Effect of Storage Temperatures and of the Maturity of Fruit.—The results of analysis of fruit stored at 50° F. and 70° F. are indicated by black (50° F.) and double circles (70° F.) in figs. 2, 3, and 4, and are shown in Table VII. The available data are insufficient to allow comprehensive comparisons, but in six out of the seven samples analysed a significantly higher percentage breakdown of asparagine is observed at 50° F. and 70° F. than in fruit stored for equal periods of time at 35° F. In each instance breakdown of asparagine is accompanied by an accumulation of ammonia, and at 50° F. by an increase in amino acids as well.

During the first forty days of storage at 50° F. the G-series fruit shows hardly any increase in protein breakdown. Thereafter rapid breakdown of protein takes place, and is accompanied by excessive "wateriness" of the green plums. The above delay in protein hydrolysis is not observed in the R-series fruit stored either at 50° F. or at 70° F. (fig. 2). Temperature effects on the nitrogenous metabolism thus seem to be related to the maturity of the fruit.

The changes in the "rest" nitrogen fractions indicate the most important difference between the R- and G-series fruit. In the ripe plums, protein degradation results in the production of amino-acid nitrogen only, as the "rest" nitrogen is completely broken down to amino-nitrogen compounds. In the G series, on the other hand, the path of breakdown of the more complex products of protein hydrolysis appears to be inhibited and "rest" nitrogen is actually accumulated.

Relation between Nitrogen Metabolism and Internal Breakdown of Plums.—The most important conclusions to be drawn from the above discussion are that under conditions of advanced maturity and high temperature of storage, nitrogenous changes in the fruit tend towards the accumulation of amino acids, whilst the secondary source of reserve nitrogen, asparagine,*

* 60 to 70 per cent. of the soluble nitrogen in the fruit at picking-time is in the form of asparagine.

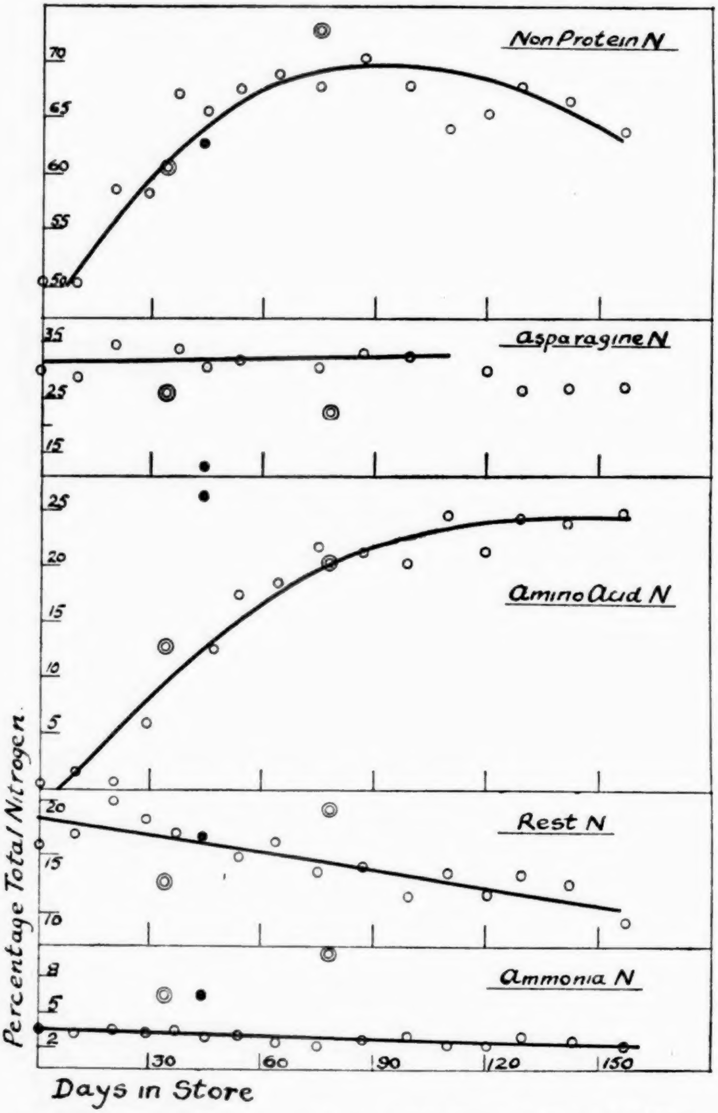

FIG. 4.—Changes in the nitrogenous fractions of the R-series fruit stored at 35° F. Equations of the fitted smooth curves are given in Table V.

Black circles represent samples of plums stored at 50° F.
Double „ „ „ „ 70° F.

breaks down to amino acids and ammonia. Low temperature and immaturity tend to inhibit these changes: low temperature prevents asparagine breakdown, whilst immaturity inhibits the accumulation of amino-acid nitrogen.

As a parallel with these chemical changes the following observations on the occurrence of internal browning in stored fruit are very suggestive. In this, as well as in previous trials, incidence of internal browning is almost completely confined to immature fruit. Browning of the flesh is most pronounced in fruit stored at 35° F., and is not observed in plums kept either at 50° F. or 70° F. Conditions of maturity and storage which interfere with the course of progressive breakdown of nitrogenous compounds are thus also the conditions which interfere with the normal ripening of the fruit and favour internal breakdown.

As a further test of this thesis a number of analyses were carried out to determine the difference in the chemical composition of browned and non-browned portions of the flesh of the plums. As browning usually occurs in the flesh around the stone and then spreads outwards, the fruit for analysis was first halved and the inner brown flesh removed with a scalpel. The results of analysis of the "inner" and "outer" portions of several samples of plums are shown in Table VIII. Some of these samples were kept for a short period at 70° F., as the incidence of internal browning in the plums is accelerated by bringing the fruit from a low to a higher temperature. Samples I–IV in Table VIII represent plums in which the brown inner portions of the fruit are more or less sharply demarcated from the outer and healthy-looking portions of the plum. In Samples V and VI the whole flesh appeared to be streaked brown, whilst in Sample VII the plums showed deep brown rings just under the "skin" of the fruit.

The most interesting phenomenon indicated by the results of Table VIII is that the total nitrogen is not evenly distributed in the flesh of the Kelsey plum. It is higher in the browned portion of the fruit, and the major portion of the difference in the nitrogen content (especially in Samples I–IV) is made up of asparagine and "rest" nitrogen. That this gradient is not due to differential evaporation of water from the "outer" as compared with the "inner" portions of the fruit is amply demonstrated by the dry-weight values. The fact that this nitrogen gradient gradually changes its direction as the browning of the flesh slowly spreads outwards, strongly suggests that the phenomenon is intimately connected with the mechanism of internal breakdown of the fruit. Prepared slides of the affected flesh revealed under the microscope that browning is accompanied by a swelling of the cells to abnormal size until they finally burst. This explains why browning of the fruit in an advanced stage results in the appearance of cavities in the flesh (6, pl. i).

TABLE VII.

CHANGES IN THE NITROGENOUS FRACTIONS OF KELSEY PLUMS DURING STORAGE AT 50° F. AND 70° F.
(G: UNRIPE PLUMS. R: RIPE PLUMS.)

All results in mgm. N per 100 grams Original Fresh Weight.

Sample and storage temperature.		G.	G 50° F.	G 50° F.	G 70° F.	G 70° F.	R.	R 50° F.	R 70° F.	R 70° F.
Days in store.		0.	44.	97.	30.	97.	0.	44.	34.	78.
Loss of weight as per cent. original fresh weight		0	8·73	15·0	10·5	25·6	0	9·2	14·1	32·5
Total nitrogen		82·8	88·3	84·4	86·7	88·3	77·3	77·4	71·6	70·0
Non-protein N		47·1	48·2	55·5	46·9	65·6	38·9	48·5	43·3	50·7
Ammonia N		2·60	3·36	7·85	3·60	4·8	2·92	5·1	4·7	7·2
Amide N		16·8	16·7	11·7	15·0	21·6	11·6	5·1	9·3	8·0
Amino N		19·9	20·6	23·5	15·6	29·0	12·1	25·3	20·2	22·2
Rest N		7·8	7·6	12·5	12·8	10·3	12·3	13·0	9·1	13·4
Protein N as per cent. total N		43·2	45·4	34·2	45·9	25·7	49·6	37·3	39·5	27·5
Non-protein N as per cent. total N		56·8	54·6	65·8	54·1	74·3	50·4	62·7	60·5	72·5
Ammonia N	Per cent. total N	3·14	3·80	9·30	4·16	5·4	3·78	6·6	6·5	10·3
	Per cent. non-protein N.	5·52	6·96	14·1	7·68	7·3	7·50	10·5	10·8	14·2
Asparagine N	Per cent. total N	40·5	37·8	27·7	34·5	49·0	30·0	13·2	26·0	22·9
	Per cent. non-protein N.	71·2	69·2	42·2	63·8	66·0	60·0	21·2	43·0	31·6
Amino-acid N	Per cent. total N	3·8	4·5	14·9	0·73	8·3	0·6	26·1	15·2	20·2
	Per cent. non-protein N.	6·7	..	21·3	1·3	11·3	1·2	41·6	25·1	27·9
Rest N	Per cent. total N	9·4	8·6	13·8	14·2	11·7	15·9	16·8	12·7	19·1
	Per cent. non-protein N.	16·6	15·7	22·4	27·3	15·7	31·0	26·8	21·0	26·4

TABLE VIII.

DISTRIBUTION OF NITROGENOUS COMPOUNDS IN THE BROWNED AND NON-BROWNED PORTIONS OF THE KELSEY PLUMS.

Nitrogen is expressed in mgm. per 100 grams Original Fresh Weight. Other values as per cent. Original Fresh Weight. Acidity expressed as Malic Acid.

I.P. indicates inner portion. O.P. indicates outer portion.

Sample.	I.		II.		III.		IV.		V.		VI.		VII.	
Days in store.	78 days in store at 35° F.		98 days in store at 35° F.		116 days in store at 35° F.		137 days in store at 35° F.		100 days in store at 35° F. plus 20 days at 70° F.		161 days in store at 35° F.		120 days in store at 35° F. plus 25 days at 70° F.	
	I.P.	O.P.	I.P.	O.P.	I.P.	O.P.	I.P.	O.P.	I.P.	O.P.	I.P.	O.P.	I.P.	O.P.
Total nitrogen	107·3	66·0	112·3	80·0	97·6	77·3	93·2	83·7	85·0	81·5	74·0	76·1	68·3	89·5
Protein N	22·9	17·8	20·6	23·4	16·2	19·6	24·6	25·6	28·5	25·3	22·6	21·9	27·3	37·2
Soluble N	84·4	48·2	91·7	66·0	81·4	57·7	68·6	58·1	56·5	56·2	51·4	54·2	41·0	52·3
Ammonia N	3·6	2·6	3·0	2·7	3·9	2·9	3·0	2·0	3·5	3·3	1·6	2·7	2·6	4·1
Asparagine N	56·4	30·2	61·8	38·1	50·6	31·2	31·4	28·8	36·8	27·6	35·7	29·0	20·2	23·3
Amino-acid N	8·0	4·6	4·5	11·1	8·5	8·7	16·6	14·4	9·9	10·4	14·2	14·2	10·9	16·6
Rest N	16·4	10·8	22·4	14·2	18·4	14·9	17·6	12·8	6·3	14·9	9·9	10·3	7·3	8·3
Dry weight	11·4	11·1	11·4	11·2	11·3	11·0	..	..	9·6	9·5	..	..	..	..
Acidity	·298	·604	·507	·639	·373	·637	..	..	·170	·402	..	..	..	..
Reducing sugar	5·47	5·49	7·05	8·09	..	..	..	..	..	..	..	..	..	..
Sucrose	1·19	1·61	·25	·65	..	..	..	..	..	..	..	..	..	..
Total sugar	6·66	7·10	7·30	7·44	..	..	..	..	..	..	..	..	..	..

Why nitrogenous compounds should accumulate in any one portion of the fruit is not very clear. The fact that such accumulation is accompanied by a considerable utilisation of acid and sucrose (Table VIII) probably indicates that the increase in nitrogen is not simply a process of migration, but is a result of a complex series of chemical changes the course of which entails considerable expenditure of energy.

Summary and Conclusions.

1. Accumulated data indicate that the nitrogen content of Kelsey plums is also a measure of the potash and phosphate intake by the fruit, and that it is connected with the keeping quality of the plums in store.

2. The investigation described in this paper has been undertaken in order to discover the extent to which changes in the nitrogenous fractions of the plums are related to the occurrence of internal browning in the fruit.

3. Two series of samples of Kelsey plums were selected. For the first series the fruit was picked when still green and immature, while the second series consisted of ripe and well-coloured plums. The fruit was stored at 35° F., 50° F., and 70° F., and the changes in the proportions of protein and non-protein nitrogen, as well as the ammonia, amino, and amide fractions, were followed by frequent analyses throughout the storage life of the fruit. A number of analyses were also carried out to determine the distribution of nitrogenous fractions in the browned and non-browned portions of the plums.

4. It has been found that rapid hydrolysis of proteins takes place in both immature and ripe fruit under all conditions of storage.

5. It is suggested that the path of protein breakdown in the Kelsey plums is: Protein N $\longrightarrow$ Rest N $\longrightarrow$ Amino N, and that the path of protein hydrolysis is arrested at the amino-nitrogen stage.

6. It is further concluded that under conditions of advanced maturity and high temperature of storage, nitrogenous changes in the fruit tend towards the accumulation of amino acids, whilst the secondary source of reserve nitrogen, asparagine, breaks down to amino acids and ammonia. Low temperatures and immaturity of fruit tend to inhibit these changes: low temperature prevents asparagine breakdown, whilst immaturity inhibits amino-acid nitrogen accumulation.

7. Conditions of maturity and storage which interfere with the course of progressive breakdown of nitrogenous compounds are also the conditions which interfere with the normal ripening of the fruit.

8. Analyses of browned and non-browned portions of plums showed that nitrogen is not equally distributed in the flesh of the fruit. It is higher in those portions of the plum in which browning of the tissue is actively proceeding.

9. The preliminary observations discussed in this paper indicate some association between physiological breakdown and the nitrogenous metabolism of the plum. These nitrogenous changes seem to be considerably affected by storage temperatures and maturity of fruit at picking-time.

Detailed studies of the problems raised in this paper are now being continued.

The author wishes to acknowledge his indebtedness to Professors J. Smeath-Thomas and R. S. Adamson, and to Dr. W. Rapson, for their helpful criticism, and to Mr. K. B. Quinan for kindly supplying the fruit for this investigation. Grateful acknowledgment is also made to Drs. Franklin Kidd and A. C. Hulme of the Low Temperature Research Station, Cambridge, for reading and criticising the final draft of this paper.

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THE FLORISBAD SKULL AND BRAIN CAST.

By Professor M. R. DRENNAN.

(With four Text-figures.)

(Read March 17, 1937.)

It has now been definitely established that a Moustierian culture was at one time widely practised in South Africa, and archaeologists have already identified Glen Grey, Alexandersfontein, Hagenstad and other variations of this Middle Stone Age. The African exponent of this Moustierian culture, however, has not yet been identified. Nevertheless there is a claimant to the distinction of having left this rich cultural legacy in the shape of Florisbad man, whose skull was discovered in 1933 by Dr. T. F. Dreyer, Professor of Zoology in the University College of the Orange Free State.

This interesting skull, which is undoubtedly the most primitive and therefore the most important human fossil thus far unearthed in South Africa, was retrieved during the course of excavations carried out under the generous patronage of Captain C. Egerton Helme. The site is at Florisbad, a warm lithium spring, situated about twenty-five miles north of Bloemfontein. Investigation has shown that as one eye of the spring becomes choked up by accumulated debris another outlet opens up. It was in one of these closed eyes that Florisbad man was discovered. That the skull is one of great antiquity is indicated by the number of extinct species of animals that have been found in close association. These include the giant buffalo (*Bubalus antiquus*) and two extinct species of horse (*Equus helmei* and *E. lylei*); many other extinct forms have been found in adjoining eyes. Professor Dreyer considers that the oldest deposits must be at least Middle Pleistocene, if not older.

Well-formed points with faceted butts were found in close association with the skull, and Mr. A. J. H. Goodwin, Archaeologist to the University of Cape Town and to the South African Museum, has stressed the Moustierio-Levalloisian affinities of the implements found in the debris, which he assigns to the Hagenstad variation of the South African Middle Stone Age. This somewhat loose association is very suggestive that Florisbad man is South African Moustierian man in a cultural sense, and I consider that the

sequel proves that he is a South African type of Neanderthal man in the physical sense as well.

In his first account of this skull Professor Dreyer (1935) admits a difficulty in naming the race to which Florisbad man ought to be assigned, but he came to the conclusion that his name should indicate his status as a very primitive form related to *homo sapiens*. He considered the differences between this skull and that of *homo sapiens* to be much greater, however, than those usually considered sufficient to separate one human species from another, so that he gave it the value of a sub-genus, calling it *Homo* (*Africanthropus*) *helmei*. Professor C. U. Ariëns Kappers (1935), on the other hand, from a study of the endocranial cast of Florisbad man, which he compared convolution by convolution with a recent human brain, seemed inclined to regard him as a type of *homo sapiens fossilis*.

In attempting to assess the morphological status of such imperfectly preserved specimens as Florisbad man unfortunately is, it is important to rely most strongly on such unequivocal facts as may be derived from a detailed examination of the existing parts. It is only at a later stage that we dare introduce hypothetical considerations, and then only with the due caution that the lack of correlation in the parts of other prehistoric skulls ought to impose upon us.

The Cranium.

The important frontal region (see fig. 1) is fortunately perfectly intact in the Florisbad skull, and it shows the following significant features. The length of the frontal bone, as measured from the frontal chord joining nasion to bregma, is 117 mm. This is only 87 mm. in anthropoids and 104 mm. in Pithecanthropus. It ranges through the definitely human group from 109 mm. in the S.A. Bushman, 111 mm. in the Australian, 113 mm. in the European, 107–117 mm. in the Neanderthal group, 119 mm. in the Galley-Hill-Brux group, to 123 mm. in Cro-Magnon man. This measurement indicates, therefore, that as regards the length of his frontal bone Florisbad man lies midway between the extremes of variation within the *genus homo*. He has, in fact, the same size of frontal bone as the Neanderthal skull from La Chapelle aux Saints. The length of the frontal arc (132 mm.) is also somewhat intermediate in the *genus homo*; it is practically the same length as that of the La Chapelle aux Saints skull.

The curve of the frontal bone of Florisbad man is decidedly flat. The degree of bulging of the forehead has been measured most frequently from the angle formed by drawing lines from the nasion and bregma respectively to the highest point on the frontal arc. In Florisbad man this angle is an open one of 143°. The range of this angle is from 130° in the S.A.

Bushman, 135° in the European, 140° in the Australian, to 143–153° in the Neanderthal group. It is important to note that this angle of frontal curvature is identical in Florisbad man to what it is in the Neanderthals from Gibraltar and La Chapelle aux Saints.

The degree of flatness of the forehead may also be indicated by expressing the height of the frontal arc above the frontal chord as a percentage of the latter. This index is 20 in Florisbad man, the same as in the Neanderthal

Fig. 1.—Photograph of the Florisbad skull, as restored by Dreyer, with the missing parts blackened over and slightly modified.

from Gibraltar, and less than what it is in the man from La Chapelle aux Saints, whose index is slightly more elevated to 23.

There is no doubt therefore that, as regards the measurements of the frontal bone and its curvature, the Florisbad skull is that of a Neanderthal; and when one takes into consideration also the prominence of the brow ridges and the flattened nature of the parietal region the resemblance between this skull and the Neanderthal skulls is very striking.

The forward projection of the eyebrow ridges or torus orbitalis of the Florisbad skull is even more pronounced than in several of the Neanderthal skulls, and their lateral expansion greatly exceeds that of all the true Neanderthals. These ridges make a span of 136 mm., which exceeds the span of *homo sapiens* by over an inch (29 mm.), and they are almost half an inch (11 mm.) wider than the maximum span of all the Neanderthals,

as shown by Spy I. In this respect Florisbad man is only slightly surpassed by the gorilla with a span of 138 mm., and by Rhodesian man with the great width of 139 mm.

Professor Dreyer has laid stress on the fact that the supraciliary and supra-orbital parts of the torus are separate elements as they are in *homo sapiens*, and lack the fusion which is said to prevail in Neanderthal skulls. This is one of his main arguments for assigning Florisbad man to a primitive subgenus of the hominidae related to *homo sapiens*. For my part I see little difference in this respect between the Florisbad brow-ridges and those of the Düsseldorf Neanderthal. There is certainly not sufficient difference to discount the other Neanderthal features of the torus.

The relative constriction of the forehead behind the torus, which is characteristic of Neanderthal skulls, is also present in Florisbad man. This narrowing can be suitably indicated by expressing the minimum frontal diameter as a percentage of the torus width. This index is 88 in Florisbad man, the same as in Neanderthal man himself and in the man from La Chapelle aux Saints. It is worth special note how greatly Florisbad man differs in this respect from Rhodesian man, whose frontal width is only 71 per cent. of his torus. He differs markedly also from the average modern skull, where there is relatively little narrowing here and the index is 93.

As regards the absolute width of the frontal region, the Florisbad skull has the great minimum frontal width of 120 mm. This is much wider than the average British width of 99 mm., and also wider than in Rhodesian man (98 mm.), Gibraltar man (102 mm.), Neanderthal man (107 mm.), and in the man from La Chapelle aux Saints (109 mm.). The maximum frontal width of the Florisbad skull is 136 mm., and this also exceeds that of all modern and all Neanderthal skulls. The ratio between the minimum and maximum frontal widths, however, is comparable to what it is in the Neanderthals, the index in the Düsseldorf skull being 88, in the La Chapelle aux Saints skull 89, in the Florisbad skull 90, and in the Spy I skull 91.

It is thus obvious that the general width of the frontal region of the Florisbad skull greatly exceeds that of *homo sapiens*, and is indeed greater than that of all the Neanderthals. Nevertheless the shape and proportions are identical to what they are in Neanderthal man, so that all the cranial features point to our regarding Florisbad man as an African representative of the Neanderthal race of Europe. There is certainly no greater difference between this African type of *homo primigenius* and the European types than there is between the African and the European varieties of *homo sapiens*. So far as the calvaria is concerned, therefore, there does not seem to be any justification for claiming new specific or subgeneric rank for this skull.

The Face.

A considerable part of the face has been preserved, and this is unusually prognathous, even more so than the face of the La Chapelle aux Saints skull (see fig. 2). The posterior border of the malar bone projects outwards

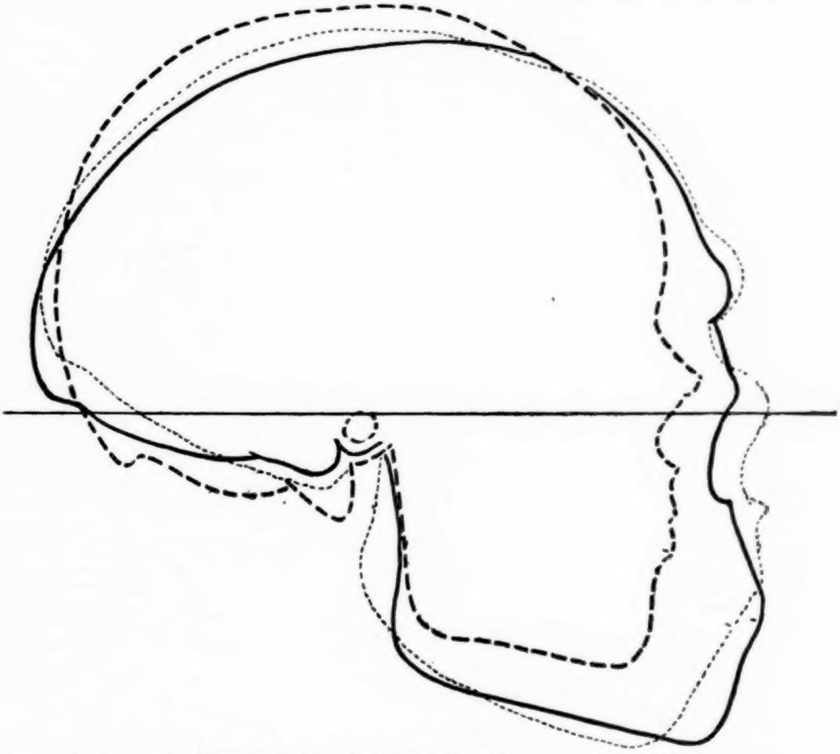

Fig. 2.—Superimposed contours of the Florisbad skull ———, the La Chapelle aux Saints skull - - - - -, and of the skull of a modern Indian — — —.

and backwards "almost as in the baboons", to use Professor Dreyer's own words. This is a very primitive feature, but there is an approximation to the condition in the Bushman, and it is a special feature of the Galilean skull. Professor Dreyer considers that the "shape of the orbits and the presence of large deep depressions on the face under them point to *homo sapiens*." I agree with this observation; it is quite in conformity with what we now know about Neanderthal man. He was not a fixed type, but was represented by quite a number of different varieties, some of the

more recently discovered skulls showing approximations to *homo sapiens* in a more or less pronounced degree. Thus the Steinheim skull, which is very similar to the Florisbad skull (Dreyer, 1936), has the general appearance of the Neanderthal type but approaches recent man to a very considerable extent. There is therefore a closer linkage between *homo sapiens* and *homo primigenius* than was at one time believed to exist, and it now seems quite possible that *homo sapiens* may have evolved, through a series of Neanderthaloid types of different degrees of primitiveness, from Sinanthropus. In Florisbad man, Rhodesian man and the Cape Flats australoid we have a closely related phylogenetic sequence from Southern Africa linking the *homo primigenius* to the *homo sapiens* type.

The Teeth.

Unfortunately only one tooth, the right third upper molar, is available for study, and its crown is considerably worn down by attrition. It is, I think, significant, however, that its roots have grown together to form a prismatic body, a feature which is very prevalent in the Neanderthal molars from Krapina, but is seldom found in recent man.

The Skull as a Whole.

Professor Dreyer has made certain assumptions with a view to ascertaining more about the missing parts, and on the whole I am in agreement with these and with his reconstruction of the skull (see fig. 1). His drawings and measurements seem to me, however, to cry out for a Neanderthal interpretation. It is, as he says, a very large flat skull measuring at least 200 mm., and in my opinion it was probably even longer (210 mm.). The cranial bone is very thick (12 mm. in the position of the frontal and parietal bosses). According to Professor Dreyer's calculations also the projection of the glabella is similar to what it is in the most obtrusive Neanderthal skulls and near what it is in Pithecanthropus. He also arrives at the conclusion that the height of the cerebrum is similar to that of the lowest of the Neanderthals. It is difficult for me, therefore, to understand how Professor Dreyer came to the conclusion he did about this skull, but, for his arguments, I must refer the reader to his own accounts of the skull (1935, 1936).

The Brain Cast.

The only knowledge we have of what the Neanderthal brain was like has been derived from a study of endocranial casts. Although these give one a good general idea of the size and shape of the actual brain, it is not an easy matter, and sometimes quite impossible, to be at all certain of the finer details of the cerebral pattern. There is, therefore, great need for

caution in attempting to decipher a brain cast, and this is all the greater in view of the fact that the morphology of the brain itself has not yet advanced to a stage when it can be relied upon as a guide to anything but the cruder taxonomic distinctions.

The endocranial cast of the Florisbad skull unfortunately shows little more than the frontal region, and even that is not quite complete, especially on the left side. There is enough, however, on the two sides from which

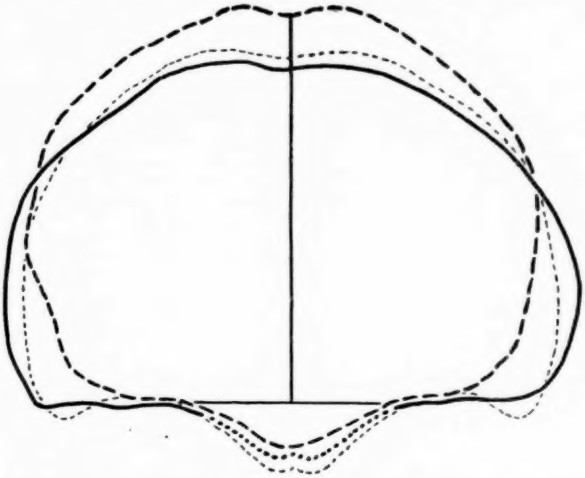

FIG. 3.—Dioptographic drawing of the "coronal suture" contour of the frontal lobe of the Florisbad endocast ——— compared with contours from the corresponding region of the La Chapelle - - - - - and a modern Bantu — — — endocranial cast.

to reconstruct almost the whole of the outer surface of the frontal lobe of this brain. In fig. 3 I have drawn a dioptographic outline of the "coronal suture" contour of this frontal region and compared it with the outlines of a corresponding part of the endocast of the La Chapelle aux Saints skull and of a modern Bantu. The contrast between the contour of the Florisbad brain and that of *homo sapiens* is very striking, but it approximates very closely to the curve of *homo primigenius*. It is, however, even flatter and wider than that of Neanderthal man and quite gorilloid in its conformation.

In his study of this endocast Kappers (1935) recognised the extreme degree of flatness of this brain and stated that it is "more flattened at the fronto-ventral end than ever observed in the Moustierian and Rhodesian types, resembling in this respect more the endocranial casts of *homo sapiens fossilis*, whose frontal lobes, however, are higher in the coronal region, the Florisbad cast being rather flat dorsally."

One of the most interesting studies of endocasts in general, and of the frontal region in particular, is that which Keith (1931) made of the brain cast of the Galilean skull. In order to get a metrical comparison of the development of the frontal region in different types he measured, on the one hand, the width between the frontal caps, and on the other hand, the height of the bregma region above the orbital margin. I have used this method to help in assessing the cerebral status of Florisbad man, and my results, together with those of Keith, are set out below in tabular form.

Endocranial cast.	Frontal height.	Frontal width.	Height plus width.	Height-width index.
Gorilla (Keith)	55	83	138	66
Pithecanthropus (Keith)	70	90	160	78
Florisbad (Drennan)	74	120	194	62
La Chapelle aux Saints (Drennan)	76	114	190	67
Gibraltar (Keith)	77	108	185	71
Galilee (Keith)	88	105	193	84
Rhodesian (Keith)	83	103	186	81
Cape Flats (Drennan)	75	101	176	74
Galley Hill (Drennan)	83	111	194	75
Australian (Keith), 1 cast	91	99	190	92
Bushman (Drennan), 1 cast	73	95	168	77
Bantu (Drennan), 1 cast	86	99	185	87
European (Drennan), 1 cast	82	104	186	79
Dean Swift (Drennan)	80	120	200	67

The figures in the above table are very instructive, and with the exception of the values for the Australian, they are on the whole consistent with what is already known about the brain in the phylogenetic series I have given. We get a metrical sequence from the gorilla with a cranial capacity of 600 c.c. to Pithecanthropus with a capacity of 900 c.c. and La Chapelle aux Saints with the huge capacity of over 1600 c.c., but after that there is on the whole a diminution in cranial capacity with fluctuations in the measurements corresponding to the size and shape of the brain. Differentiation of cerebral structure seems to be as important as brain size and much more important than brain shape in determining cerebral status.

So far as measurements are concerned, therefore, the table forms a convenient scale with which to assess the status of the Florisbad brain. I think the measurements justify his being grouped with the Neanderthals rather than with *homo sapiens fossilis* (Cape Flats and Galley Hill) as Kappers (1935) has done, or with the Bushman as Dreyer (1936) has done. The Galley Hill cast is, as Kappers admits, considerably higher in the

coronal region, and it is also definitely narrower than the Florisbad one. The Cape Flats and Bushman casts have both about the same frontal height as the Florisbad one, but this last is three-quarters of an inch wider than the Cape Flats brain and quite an inch wider than the Bushman brain in this region, so that any alignment with these is not a very just one.

In the fourth column of my table the height is expressed as a percentage of the width, and this gives a numerical indication of the degree of flatness of the frontal region of the endocasts. It is quite obvious that, contrary to the prevailing opinion, the degree of elevation of the frontal lobe is no criterion of morphological status. The height-width proportions of the frontal region of Dean Swift are the same as those of the gorilla, and the European brain in general is not very different from Pithecanthropus in this respect. On the other hand the Australian, the Bantu, the Galilean and Rhodesian brains are relatively high in the frontal region.

The credit for this dethronement of elevation of the frontal region as an indication of cerebral advancement belongs, however, to Weidenreich (1936), who in the course of his investigation of the brain cast of Peking man found that "as to enlargements in height, the height of the frontal lobe exhibits on the whole the same proportion (to the length of the brain) in anthropoids, Pithecanthropus, Sinanthropus, Neanderthal and recent man."

Thus the extreme gorilloid flattening of the Florisbad frontal region, which at the commencement of this investigation I thought might have generic value, turns out to have a very limited significance. There is this to be said for it, however, that it is consistent with his being a Neanderthal, for the true Neanderthals have a flat frontal region, whereas in *homo sapiens* this is sometimes greatly elevated. Fortunately, however, the Florisbad brain cast also shows a considerable part of the posterior frontal and parietal regions of the vertex of the brain. It is in this region behind the bregma that, as Weidenreich (1936) points out, we must look for high or low morphological status in a brain or brain cast. Now as in the case of the skull (see fig. 2), so in the Florisbad brain cast the bregma region is highest, and there is quite a marked downward slope of the contour of the skull and brain from the bregma backward. This presents a striking contrast to the conformation of this region in *homo sapiens, homo primigenius*, sinanthropus and even the anthropoids, where there are varying degrees of elevation of the brain behind the bregma region. In this respect the Florisbad brain cast shows affinities with Rhodesian man and Pithecanthropus, which last two types have low, flat, parietal regions. There is no doubt, therefore, that the Florisbad brain as a whole was low and flat, even lower and flatter than the Neanderthal brain, and therefore very primitive and quite out of the category of *homo sapiens*, recent or fossil.

In order to throw up the pattern of the sulci and gyri on the endocast,

I used the following process. The cast was painted over with a coat of thin black paint, the thin paint tending to collect more in the fissures than on the convolutions. While the paint was still wet, the surface of the cast was wiped with a cloth damped with turpentine and stretched over a small block of wood. This intensifies the lights on the convolutions, and the flatness of the wiper prevents it from removing the paint from the fissures. Fig. 4 shows a photograph of the endocast thus treated.

Fig. 4.—Photograph of the endocranial cast of Florisbad man, taken somewhat obliquely.

The sulci and gyri are fairly well marked in the region of maximum convexity, but they fade away towards the coronal and sagittal regions, owing to the presence here of the sub-arachnoid streams of cerebro-spinal fluid. These streams, especially the former, are well marked on this cast and they lead up to a bulging bregma pool. All the above features are much better marked than on a modern brain cast, and this in itself is, according to Keith (1931), a sign of human primitiveness.

It is a relatively easy matter to make out the four antero-posterior sulci and the five tiers of horizontal frontal convolutions demarcated by them; it is, in fact, possible to institute a quite close comparison, sulcus for sulcus and gyrus for gyrus, with the brain of modern man, as Kappers (1935) has already done with a European brain, and as Dreyer (1936) has done with a Bushman endocast. Cunningham (1892), however, pointed

out long ago that in the chimpanzee the same convolutionary tiers may be seen as in man with the exception that the superior frontal gyrus is never split into two by a sulcus frontalis mesialis, a sulcus which is nevertheless sometimes also absent in lower types of human brain. Nor is there much difference in the cerebral patterns that have been established for the brains of *homo sapiens* and *homo primigenius*. The degree of development and differentiation of the inferior frontal convolution, the important area which on the left side in right-handed people lodges the speech centre, is, however, very different in the apes from what it is in man. Kappers (1929), in his study of the endocranial casts of Neanderthal man, makes a statement that suggests that the brains of members of this race are somewhat poorly differentiated in this region. Thus he says "that the two rami anteriores fossae Sylvii limiting a distinct operculum frontale are nowhere seen, nor a fiss. axialis operculi frontalis. The former may be indicated by 2? on both sides of the Düsseldorf cast and on the right side of the Rhodesian and left of the Chapelle cast."

It is significant in this connection that when Kappers compared the Florisbad brain with a modern one, it was with a modern brain deprived of a considerable portion of its inferior frontal convolution that he instituted his comparison. My own opinion is that the inferior frontal convolution of the Florisbad brain is relatively poorly developed and differentiated. The whole appearance of the frontal lobe of Florisbad man looks, in fact, identical to what Kappers (1929) has figured as his interpretation of the left side of the brain of the Neanderthal from La Chapelle aux Saints.

Conclusion.

This paper is an attempt to give an independent evaluation of the morphological status of Florisbad man. Professor Dreyer, the discoverer, first considered it belonged to a new subgenus of *hominidae*, but latterly seems inclined to regard it as a type of *homo sapiens fossilis* belonging to "the prehistoric South African race—the Bushman, of which he is a very early and very primitive representative." Ariëns Kappers, from the limited study of its endocranial cast, has also placed it with *homo sapiens fossilis* rather than with Moustierian or Rhodesian man. The author (1935), on the other hand, has already maintained that Florisbad man is best interpreted as an African variant of the Neanderthal race, suitably labelled as *Homo florisbadensis* (*helmei*). He now submits fuller evidence from the skull and brain cast, which in his opinion substantiates this conclusion.

For the opportunity of studying this somewhat enigmatical human fossil the author is greatly indebted to Professor T. F. Dreyer, whose courtesy and kindness in lending the skull and in presenting a brain cast is now gratefully acknowledged.

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STUDIES OF SOUTH AFRICAN SEAWEED VEGETATION.

I.—West Coast from Lamberts Bay to the Cape of Good Hope.

By Wm. Edwyn Isaac.

(With Plates I–II and six Text-figures.)

(Read March 17, 1937.)

CONTENTS.

Introduction.

The coastal waters of South Africa afford contrasting temperature conditions, due to the existence of a cold current along the west coast and a warm current along the east and south coasts. These differences have their effects both on the algal flora and vegetation. Further, within each of these thermal regions there is a temperature gradient which results in very definite, although less spectacular, changes.

This is the first of a short series of papers dealing with the algal vegetation of South African coasts in relation to different temperature conditions. An account of the general and salient features of the algal zonation is also involved since this has not previously been described.

Scope and Limitations of the Present Investigation.

Sub-divisions of the Shore.

The shores of tidal seas have been variously sub-divided by investigators of algal species and vegetation, the sub-divisions adopted, together with their limits, depending to some extent on the geographical region.

In this paper the term littoral area is used to denote the region from the upper limit of algal growth to the lowest tidal level of spring tides. This corresponds to the littoral region of Kjellman (1877) and also essentially to the region of algal growth above "Chart Datum" used by Grubb (1936). As the upper limit of algal growth substantially coincides with high-water mark of neap tides there can be no question of a supra-littoral region.

The term sub-littoral is here used for the vegetation occurring beyond low-water mark of spring tides, but cognisance is taken only of the outstanding features of the dominant stratum visible at the surface of the sea. Below the kelps there may be tiers of vegetation as in a forest. In some localities small outliers of kelp are left exposed at very low tides, and in such cases the kelp vegetation is regarded as belonging to the sub-littoral and not to the littoral region.

Limitations of the Investigation.

Apart from the principal features of the upper stratum of the sub-littoral zone, this investigation was concerned with the littoral vegetation exposed on rocky coasts during the ebb of both spring and neap tides. The vegetation of rock pools is either not dealt with or, except for Melkbosch, is only dealt with incidentally since the vegetation of rock pools constitutes a study in itself. Again, the algal vegetation of sandy substrata is not dealt with except for the outstanding features of the sub-littoral

vegetation rooting in sand at Langebaan. A sandy substratum is of relatively limited occurrence along the stretch of coast investigated, and wherever found has practically no algae growing on it within the littoral area. Finally, no account is included of the algal vegetation of detached rocks a little out to sea and inaccessible at low tide.

No attempt is made to present complete lists of species from the various localities studied. Those species have been listed which are abundant (dominants, co-dominants, etc.), characteristic, or, for one reason or another, interesting or significant. Indeed, without further taxonomic study, complete lists cannot be drawn up, and mere lists of species from various localities are of little ecological significance. A species typical of a certain habitat may have a wide distribution if it can tolerate a wide range of conditions. Outside the range of its occurrence as a dominant, sub-dominant, or common species, it frequently, however, has little ecological significance, or occurs as a rarity or is restricted to rock pools; and growing under such conditions it may show a stunted growth not typical within the range of its occurrence as an ecologically prominent species. Lastly, outside its geographical range, it may become quite common locally in circumscribed areas.

Seasonal Changes.

The seasonal changes are relatively small and do not affect the general character of the algal vegetation. Thus no zone of algal growth completely disappears as does *Porphyra umbilicalis* during the summer months in many parts of the South of England (Grubb, 1923, 1936). Neither is the dominant species of any zone replaced by another during part of the year in the way that *Fucus vesiculosus* in the summer replaces *F. serratus* as dominant at Peveril Point, Dorset (Grubb, 1936).

There are, however, seasonal changes, such as a more luxuriant growth of some species, at certain seasons, but sufficient data are not yet available. For this reason, and since the general features of the algal vegetation remain unchanged throughout the year, seasonal changes are not dealt with in this paper, or at best some such changes are dealt with incidentally.

Sub-division into Regions of the Coast-line Investigated.

In order to emphasise and throw into perspective the outstanding changes and modifications of algal vegetation related to the gradient of changing sea conditions as opposed to local conditions, the localities studied —with two exceptions—have been grouped together into a number of regions. The delimitation of these regions is tentative, since there are long stretches of coast which have not been visited. This is especially true of

the region between Capetown and Lamberts Bay, since the distance between the localities studied is much greater than along the west coast of the Cape Peninsula. Saldanha and Dassen Island lie outside this grouping; the former because of exceptional topographic factors, and the latter, since it is an island subject to different sea-temperature conditions as compared with the opposite mainland (see p. 121).

The sub-division adopted is as follows:—

Region I. Lamberts Bay and Yzerfontein.
Region II. Melkbosch.
Region III. The north and north-central coast of the Cape Peninsula.
Region IV. The southern end of the Cape Peninsula.

Environmental Conditions.

The west coast is subject to the influence of upwelling cold water of sub-antarctic origin—the Benguela current—which is relatively rich in phosphates and nitrates. It is at first a deep-water current which gradually comes nearer the surface causing surface sea temperatures to drop as the tropics are approached until the region of minimum temperature is reached. Thereafter the temperature rises again until gradually the Benguela current turns westwards and merges in the tropical current system of the Atlantic. Farther away from land, beyond the Benguela current, the temperature of the sea again rises (*e.g.* see Dietrich, 1935). Thus there are two gradients of temperature change: a gradient of increasing sea temperature from east to west, and a gradient of decreasing temperature from south to north as far as the region of minimum temperature. The changes in temperature to the west of the main current are not considered in this paper. The view has been put forward by Marchand (1932) that the region of minimum temperature lies between Hondeklip Bay and Luderitz, moving north and south during the course of a year over a distance of about 280 miles. The "African Pilot," however, places it as far north as latitude 16° S. (African Pilot, 1930). At Waltis Bay, just within the tropic of Capricorn, the average annual temperature is only 16·1° C. This is 5·7° C. lower than the average annual temperature of Durban (21·8° C.), which is about seven degrees latitude farther south on the east coast and subject to the influence of the warm Mozambique current. These temperature conditions make intelligible Schinz's discovery in 1890 of *Laminaria* (*L. Schinzii*) growing at Walvis Bay. The Laminariaceae are inhabitants of cold and temperate seas and this is the only record of a *Laminaria* occurring within the tropics. It would seem that the species is not of rare occurrence in the locality: "Laminarien finden sich dort in Menge an Steil-küsten von einer Tiefe von 3 m.an." (Foslie, 1893, p. 91). In addition to the main current a

few miles out to sea there are counter currents flowing close inshore in an opposite direction. Again, within the sphere of influence of the

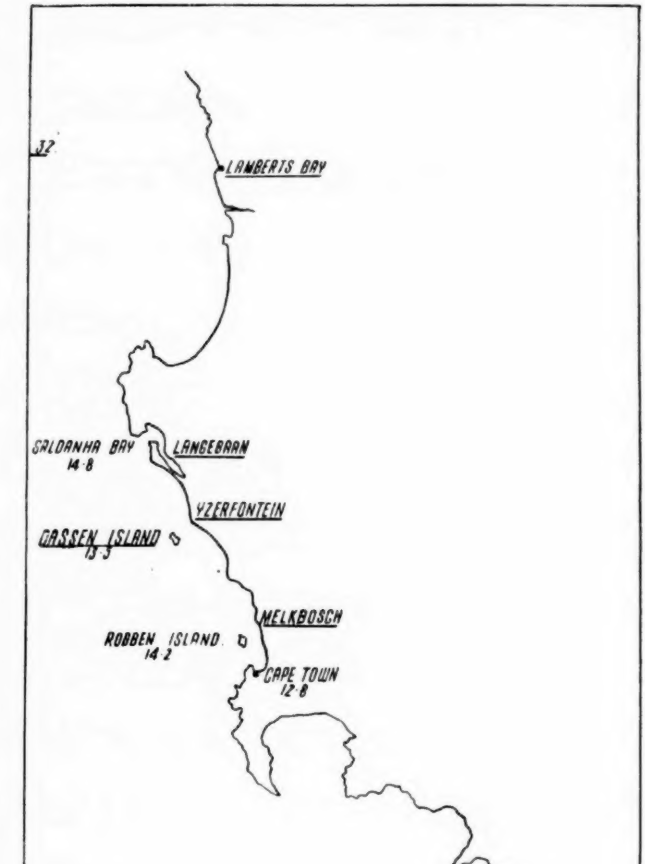

Fig. 1.—Map of the coastline investigated showing the available average annual surface temperatures.
Studies of algal vegetation were made at the localities underlined.

summer south-easters, the winds blow the surface waters out to sea, resulting in the upwelling of colder waters close inshore. Thus, at any given point, the inshore water will tend to be colder than that a few miles

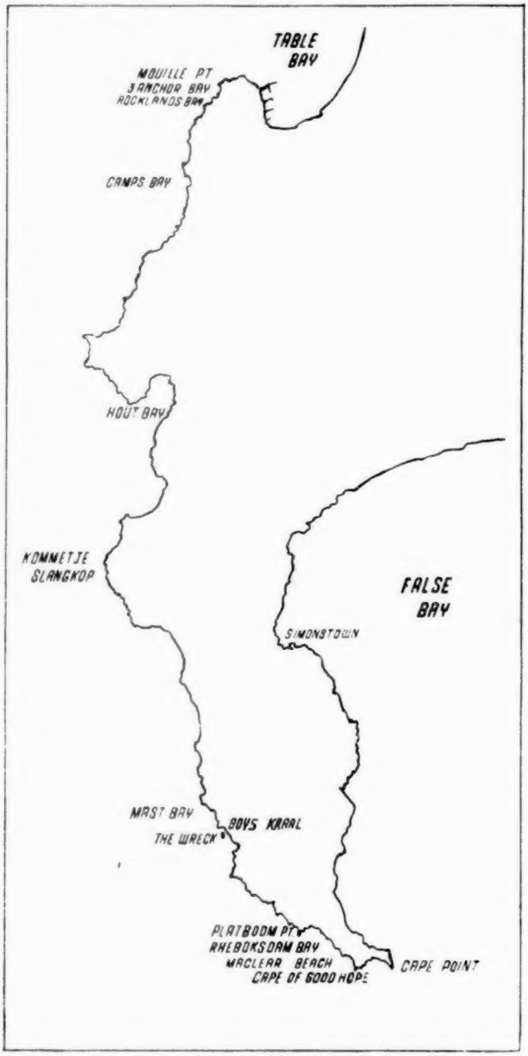

FIG. 2.—Map of the Cape Peninsula showing the West Coast localities where the algal vegetation was investigated.

out to sea. In addition to the evidence given below, Gilchrist (1902) also presented evidence of higher temperatures out at sea in the region of

the Cape Peninsula. Consequently, in considering existing temperature records, it is necessary to distinguish between coastal stations on the one hand and island stations a few miles from the mainland on the other.

The most northern locality studied—Lamberts Bay, about 160 miles north of Cape Point—is well south of the region of minimum temperature, and so in general there is a continuous fall in temperature from south to

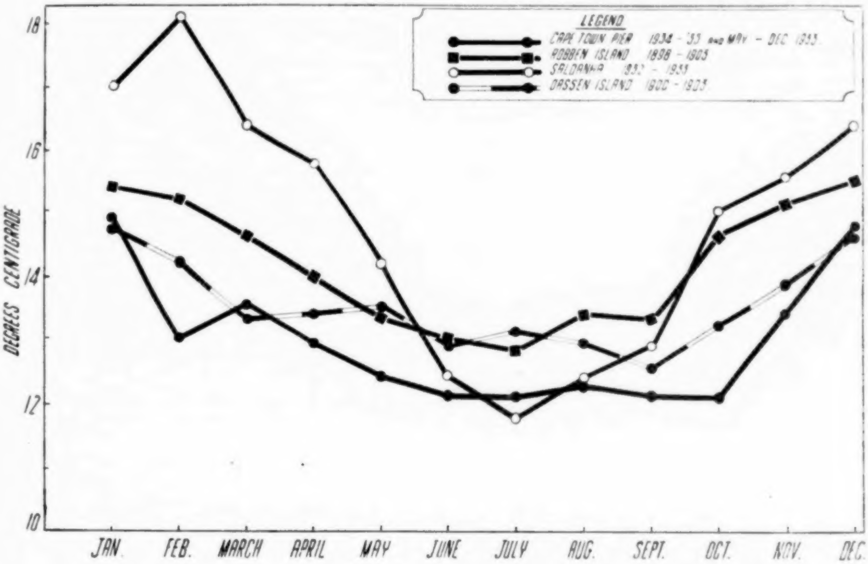

Fig. 3.—Curves showing the average monthly temperatures for the four temperature stations shown in fig. 1.

north along the extent of coast-line investigated. Fig. 1 gives the available sea temperatures for this region, and figs. 1 and 2 give the localities where studies of algal vegetation were carried out. The seas off Robben and Dassen Islands have higher temperatures than the inshore waters of the opposite mainland. Available temperature data (fig. 1) indicate that the average annual temperature of the sea off Capetown Pier is lower than that off Robben Island (and also Dassen Island), and, as the sequel will show, the algal vegetation of Dassen Island indicates a higher sea temperature than that of the inshore water at Yzerfontein. Saldanha is a protected bay at the head of a shallow lagoon extending for about 9 miles in a more or less south-south-easterly direction and only 1 to 2 miles wide. The waters of this lagoon are warmed by the sun, which accounts for the relatively high sea temperature.

The differences between the maximum and minimum monthly average temperatures for Capetown Pier, Robben Island, and Dassen Island are 1·2° C., 2·7° C., and 2·3° C. respectively. The corresponding value for Saldanha, however, is 6·35° C. Thus, with the exception of Saldanha, the sea temperatures at these stations remain fairly constant throughout the year (fig. 3). The minimum monthly average temperature at Saldanha (11·8° C.) is lower than at the other temperature stations, while the maximum monthly average temperature (18·15° C.) is the highest of the four maximum values. The lower minimum at Saldanha may be due, in part, to the action of the winter north-west winds blowing in the waters from outside, which would be colder than the waters to the south, while the higher maximum can be attributed to the warming by the summer sun of a protected body of water.

From Capetown northwards to Cape Frio the tidal range increases from 4·6 feet to 5·7 feet (Bauer, 1933). Thus the average tidal range of the region investigated can be regarded as about 5 feet. The spring and neap tide ranges for Table Bay are as follows:—

Springs . .	5 feet
Neaps . .	$3\frac{1}{2}$,,

The sea along the west coast has a powerful swell, much more so than along the east and south coasts. Consequently, heavy seas beating against very exposed coasts often result in the presence of little or no algal vegetation.*

THE ALGAL VEGETATION.

PART I.—THE ALGAL VEGETATION OF MELKBOSCH.

Introduction.

The general character of the algal vegetation of the west coast will be best understood if a single locality is first considered in greater detail. Melkbosch has been selected for this purpose since the locality has a rich algal growth, is free from any appreciable human interference, and the zonal sequence of algae is not too complex.

Melkbosch (fig. 1) is situated on an exposed coast. Especially under the influence of north-west winds the seas are very high, and even in the

* Further details regarding temperature and other oceanographical conditions along the west coast will be found in the writer's paper: "South African Coastal Waters in Relation to Ocean Currents," published in the October number of the *Geographical Review*, vol. xxvii, No. 4, 1937.

absence of wind there is often a considerable swell. The rock is Malmesbury shale, and the tilted strata lie at an angle to the sea. Rock pools are fairly numerous, often very large and sometimes deep. There are also large pools directly connected with the sea at low water.

From a distance two zones stand out very prominently with a fairly considerable intervening space which appears somewhat barren and in part is so. The lowermost and by far the more extensive of these, dominated by kelps, is sub-littoral, and thus the algae are never exposed in the sense that the *Laminaria digitata* zone is exposed during spring tides on British coasts. The tips of the algae, however, stand up a little above the surface of the water (Pl. I). The other zone which stands out prominently is the *Porphyra* zone (fig. 2, Pl. II).

The littoral zones, in order from the sub-littoral zone upwards, are as follows:—

The *Champia* zone.
The *Iridaea* zone.
The Bare zone.
The *Chaetangium* zone.
The *Porphyra* zone.

The first two of these zones extend upwards to about the level of low water of neap tides (figs. 4 and 5). The Bare zone and the two upper zones are exposed at every tide. The uppermost reaches of the littoral area are not colonised by algae, the whole of the algal vegetation being covered by every tide (fig. 4). This will be realised if it is borne in mind that generally the bulk of the *Porphyra* zone is regularly washed by the sea after a period of five to six hours' exposure. Eight to nine hours can be regarded as the maximum exposure period for the upper limits of the *Porphyra* zone. A heavy wind—especially a north-west wind—will greatly reduce the period of total exposure by hurling huge waves far upshore and so wetting the highest littoral algae much sooner than would otherwise be the case.

The Sub-Littoral Zone.

This zone is very well developed and is much more extensive in area than the entire littoral vegetation (fig. 4). The prominent species are *Ecklonia buccinalis, Macrocystis pyrifera, Laminaria pallida*; all are members of the Laminariales. These species represent the upper stratum observable at the surface of the sea. Of these *Ecklonia buccinalis* is undoubtedly dominant, and determines the general appearance of the zone as seen from some distance. This is due not only to the predominance of

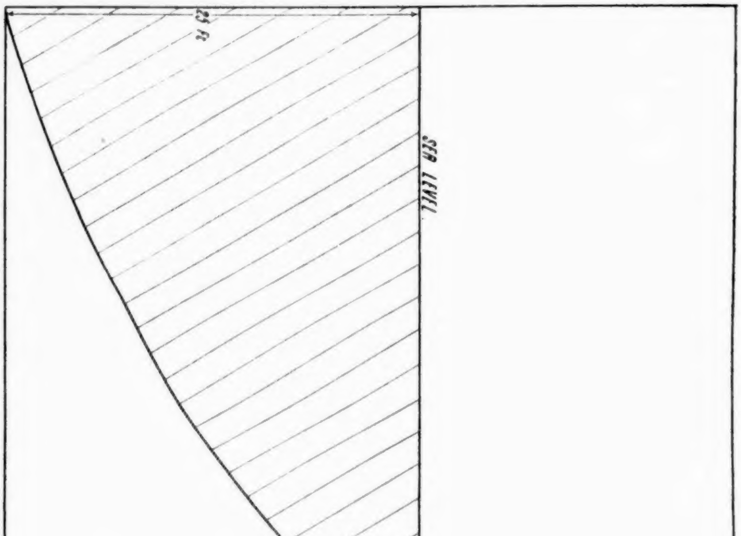

Fig. 4.—Diagrammatic section of the shore at Melkbosch showing the proportion of permanently submerged vegetation to the vegetation between tidemarks, and the disposition of the latter in relation to the different tidal levels. The position of the low water-level of neap tides, as shown in this figure, is only approximate.

the species but also to the manner in which the stiff lanceolate central portion of the frond, which bears the limp frond segments, emerges upright from the water (Pl. I). In this it is aided by the buoyancy of the hollow

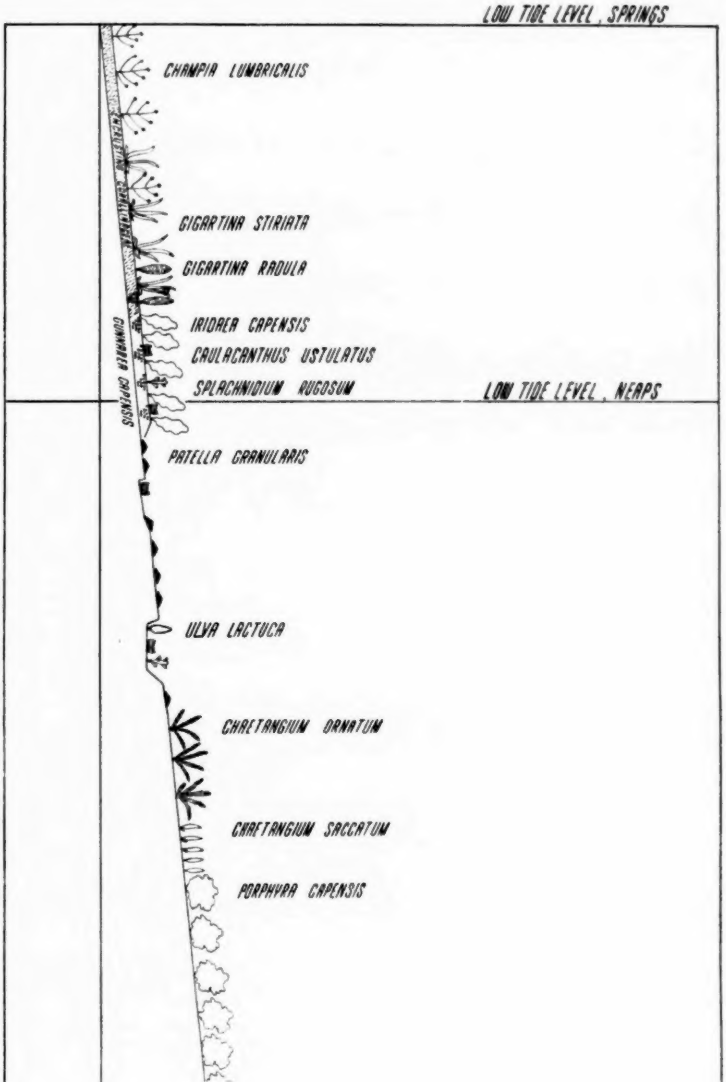

FIG. 5.—Diagrammatic profile chart of the littoral vegetation at Melkbosch.
The position of the low water-level of neap tides as shown in this figure is only approximate.

stipe,* which tends to become somewhat enlarged near its tip.† *Laminaria* is common and in some places is dominant in the inner reaches of the sub-littoral zone. It also extends sometimes into some of the larger pools situated in the lower reaches of the littoral region. *Ecklonia* also extends sometimes into the littoral region, occurring in pools that are directly connected with the open sea. *Macrocystis pyrifera* is not widespread, but locally it may be very abundant. It seems unable to withstand the full force of the waves, since at Melkbosch it is typically found in the inner part of the zone, where it is protected from the full force of the open sea by a palisade of *Ecklonia* (Pl. I, A). This habit is characteristic of the species throughout its limited range of distribution at the southern end of the west coast of Africa. In other parts of the world it seems able to withstand heavy seas. This is certainly the case on the coasts of Tierra del Fuego (Darwin, 1845). It is possible that in South Africa the species is unable to root at as great a depth as *Ecklonia*.

On *Laminaria* and particularly on *Ecklonia*, a large number of epiphytes are frequently found. The commonest of these epiphytic species are *Carpoblepharis flaccida*, *Polysiphonia virgata*, and *Suhria vittata*.

Suhria vittata is much less common as an epiphyte than the other two species. *Polysiphonia virgata* is almost invariably found epiphytic on the stipe, while *Carpoblepharis flaccida* is usually found on the frond.

The Lowest Littoral Zone.

The rock surface at this level is mostly covered by encrusting Corallinaceae forming a lower stratum. The tube constructions of *Gunnarea capensis*, a polychaete worm, also occur in this zone. The upper stratum of vegetation is dense and is dominated by *Champia lumbricalis*, *Gigartina stiriata*,‡ and *G. radula*.§ The most abundant and constant species throughout is *Champia*. This zone is usually divisible into two sub-zones,

* Hence the popular name, the sea bamboo.

† Ecklonias stranded on the beach and exposed to the air for some time display a large float-like structure due to abnormal distension of the upper end of the stipe.

‡ Most of the individuals are Carposporic. Tetrasporic individuals (*G. Burmani*) also occur at the same level but they are far less common.

§ According to Setchell and Gardner's classification of the genus *Gigartina* (Setchell and Gardner, 1933), the name *G. radula* refers to an Australian species which is represented in South Africa by a number of species of the sub-genus *Chondrodictyon*. As the writer understands it, *G. radula*, as it occurs in the lowest littoral zone of the west coast from Lamberts Bay to the Cape of Good Hope, would correspond largely to *G. polycarpa* (*Mastocarpus polycarpus*, Kütz) and also to some extent to *G. incrassata* (*M. incrassatus*, Kütz).

Until further work is done on the South African forms of *Gigartina*, the writer considers it expedient to retain the name *G. radula*, thus following the practice adopted for South African forms by Agardh and later by De Toni.

the lower dominated by *Champia* and the upper dominated by *Gigartina*. In the less sheltered places *Champia* and *G. stiriata* are dominant, but *G. radula* becomes dominant in more sheltered places, *Champia* tending to disappear. In the most exposed places *Champia* becomes relatively and absolutely more abundant and *Gigartina stiriata* tends to disappear. This zone is also characterised by the presence of *Patella cochlear*, on the shells of which *Ceramium clavulatum* is found growing.

Champia is confined to narrow limits at low-tide level and to the larger and deeper rock pools. The two species of *Gigartina*, however, and especially *G. radula*, have a wider vertical range, for they extend upwards into the lower reaches of the zone next above and sometimes even higher. In addition *G. radula* and *G. stiriata* are common in rock pools, and especially in those pools found in the lower parts of the littoral area.

The following species also occur in this zone:—

Pterosiphonia cloiophylla, which forms small societies in the more exposed situations. *Hypnea spicifera*—usually an occasional member of the rock pool flora, but occurring locally on rocks exposed by low spring tides.

The Iridaea *Zone.*

Throughout this zone the coarse-grained tube colonies of *Gunnarea capensis* are very prominent. The zone is narrow and the vegetation is not dense and is of a somewhat indefinite character. *Iridaea capensis* is the most common and constant species, the individuals being of large size. The other most common species are *Caulacanthus ustulatus* and *Splachnidium rugosum*. The former is a common species occurring at wide and irregular intervals as small compact cushions usually about an inch to an inch and a half diameter. The latter is an occasional member of the zone, often occurring in small groups. *Caulacanthus ustulatus, Ceramium diaphanum*, and *Ulva* are found growing on the tube colonies of *Gunnarea*.

The Bare Zone.

This is a prominent and broad zone for the most part devoid of algal vegetation. Limpets (*Patella granularis*) are the commonest and most constant inhabitants of exposed rock at this level. Other inhabitants of the exposed rock are *Lepadoderma africanum* and also barnacles.

A fair number of damp places, cracks, and small pools break up the continuity of this zone, and these damper habitats support a denser and more varied population consisting of invaders from above and below, but more especially from lower levels. The cracks and damp depressions are carpeted by encrusting Corallinaceae and the tube colonies of *Gunnarea*

capensis, on which are found *Ulva* and *Caulacanthus ustulatus*. *Splachnidium rugosum* and *Lepadoderma africanum* are also found in these habitats. *Porphyra capensis* and *Chaetangium ornatum* are occasional invaders from higher levels.

It is reasonable to suppose that the exposed parts of this zone are not invaded from below as the algae of the lower zones are unable to withstand both the longer exposure periods and the increased incidence of emergence, since the lower zones are not exposed at every neap tide. It is difficult, however, to see why the exposed habitats of this level should not be invaded from above by the two species of *Chaetangium* and especially by *Porphyra*. The upper zones are exposed at each tidal period and are covered by every tide—conditions which prevail in the Bare zone below their limit. Also, since these species extend far down into the littoral area in damp places, it would seem that a long period of exposure is probably not necessary for these species. At Melkbosch, *Porphyra capensis* does not extend much beyond the uppermost algal zone. Experimental evidence is available, however, indicating that although *P. capensis* is capable of colonising the lower levels of the littoral region below the Bare zone and can flourish for a longer or shorter period, it is, nevertheless, unable to establish itself (Bokenham, unpublished paper). This suggests that the *Porphyra* found in damper places at lower levels may be transient and frequently renewed, for the species is capable of rapid growth (Bokenham).

Grubb describes a similar Bare zone in the littoral region at Peveril Point on the Dorset coast. The reasons for its existence are not clear, but it is suggested that it is due to the more rapid rise and fall of the tide at this level together with the greater fluctuation in the periods of exposure at different times of the year as compared with other levels above "Chart Datum" (Grubb, 1936).

The Chaetangium *Zone.*

At its maximum development this penultimate zone is dominated by *Chaetangium saccatum* and *C. ornatum* as co-dominants. After early summer *C. saccatum* seems to undergo a rapid decline in numbers, so that by midsummer *C. ornatum* becomes relatively more abundant and *C. saccatum* less abundant. This matter, however, needs further investigation. For the most part these two species do not intermingle but form pure societies. Mostly this segregation of the species is into two sub-zones, the upper being a sub-zone of *C. saccatum* and the lower dominated by *C. ornatum*. At Melkbosch the *Chaetangium* zone is fairly well developed.

This zone overlaps only to a very limited extent with the zone next above, and so *C. saccatum* is only very rarely protected from desiccation by

Porphyra. Both species of *Chaetanguim*, and especially *C. saccatum*, often undergo severe desiccation during inter-tidal exposure. *Porphyra capensis* is also sometimes found in this zone.

The Porphyra *Zone.*

This dense and extensively developed zone is dominated by *Porphyra capensis* (fig. 2, Pl. II). *Porphyra* is a widely distributed genus occurring well within the Arctic circle and throughout the temperate regions of both the northern and southern hemispheres and, at least in Ceylon, extending into the tropics. In warmer waters, however, it frequently, if not usually, flourishes only during the winter months (Oltmanns, 1923; Grubb, 1924), and an entire zone dominated by *Porphyra* may completely disappear during the summer (*e.g.* Grubb, 1924, 1936).

At Melkbosch, *Porphyra* flourishes best in winter and early spring and shows a limited decline in density and upward extension in early summer. By midsummer some of the uppermost plants show signs of discoloration and unhealthy condition, but this is not a marked feature of the locality, and these changes are decidedly less evident at Melkbosch than in localities farther south. Thus the *Porphyra* zone persists throughout the year without any essential change.* This is further supported by numerous observations made for every month of the year at other localities on the west coast, although the amount of seasonal change increases southwards.

The Algal Vegetation of Melkbosch in relation to other West Coast Localities studied.

The algal vegetation at Melkbosch shows all the features which are constant for, and characteristic of, the west coast region from Lamberts Bay southwards. These features, which are summarised in figs. 4, 5, and 6, are as follows:—

(1) A growth of large kelps beyond low-tide level of spring tides.

(2) The constant presence of *Champia lumbricalis* at low-tide level of spring tides.

(3) The presence of a narrow and somewhat ill-defined zone, the most constant and characteristic species of which are *Iridaea capensis* and *Caulacanthus ustulatus*.

(4) A bare zone devoid of algal vegetation except for rock pools, shallow damp depressions, and cracks in the rock. This zone, however, serves as a habitat for limpets (*Patella granularis*).

(5) A penultimate zone dominated by *Chaetangium*.

* Detailed studies were carried out at Melkbosch during December, January, February (Summer), end of March (Autumn), July (Midwinter), and September (early Spring).

(6) The uppermost zone dominated by *Porphyra capensis.* This zone is washed or covered at every tide and persists throughout the year.

Rock Pool Vegetation.

Ulva lactuca is frequently a dominant species in the upper rock pools. In the lower rock pools there is usually no well-marked dominant, but *Gigartina radula* and *Iridaea capensis* (large-sized individuals) are very common.

Below is given a further list of rock pool species.

Common and fairly Common Species.—*Chordaria capensis ; Gigartina fastigiata*—also species of *Gigartina* mentioned above; *Codium fragile, C. Stephensiae* (the latter is local in its distribution); *Champia lumbricalis ; Grateloupia filicina ; Ceramium* spp., including *C. clavulatum ;* Corallinaceae, especially *Cheilosportum palinatum ; Cladophora* spp., including *C. flagelliformis* and *C.* ? *Eckloni.*

Occasional and Rare Species.—*Hypnea spicifera, Bifurcaria laevigatus, Plocamium corallorhiza, Chaetomorpha clavata, Champia compressa, Bryopsis plumosa, Chylocladia capensis, Suhria vittata, Enteromorpha compressa, Dicurella flabellata, Gymnogongrus polycladus, G. vermicularis.*

The algal flora varies considerably from one rock pool to another, and so it is not possible to give a general account of the rock-pool vegetation without considerable further investigation.

Part II.—The General Features of the Algal Vegetation from Lamberts Bay to Cape of Good Hope.

Introduction.

The algal vegetation of Melkbosch has been considered in some detail. All the zones of algal vegetation which are constant throughout the region investigated occur in this locality. Farther south, however, there are additional algal zones not found at Melkbosch (fig. 6). The algal vegetation of the west coast at its maximum development in regard to variety of species and complexity of zonation shows the following sequence of zones:—

A. The sub-littoral zone.

B. The lowest true littoral zone. *Champia lumbricalis* is the most constant and characteristic species.

C. A zone dominated by *Bifurcaria brassicaeformis.*

D. A narrow and ill-defined zone, in which *Iridaea capensis* is the most characteristic and conspicuous species, though often of low absolute frequency.*

* Actual number of individuals of a species per unit of the plant community. See Arrhenius (1922).

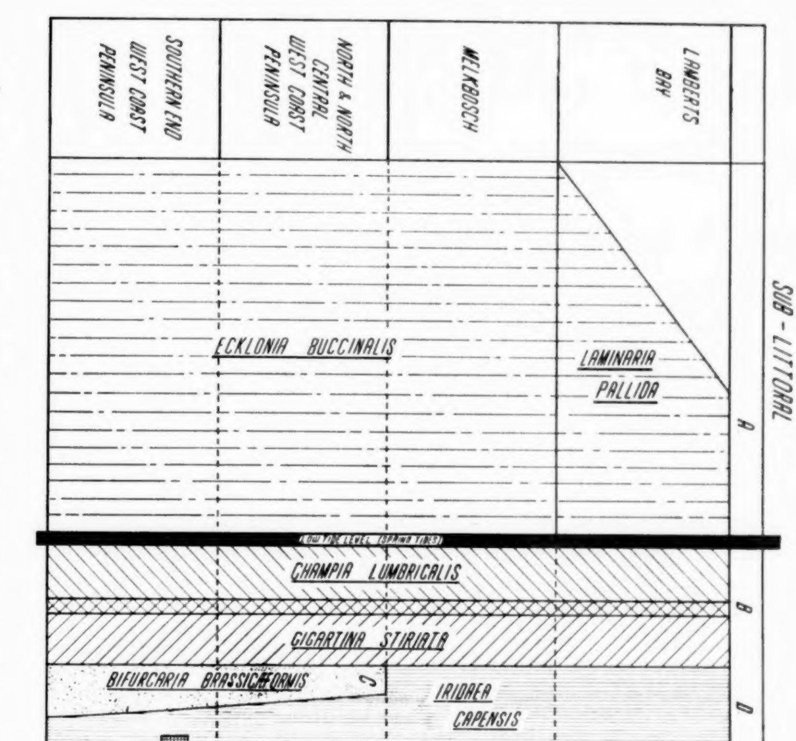

Fig. 6.—Diagram showing the distribution of the chief species together with the changes in the character and the increase in complexity of the zonation from Lamberts Bay to the Cape of Good Hope.

For diagrammatic purposes the extent of the sub-littoral vegetation has been reduced. It is usually of considerably greater extent than the littoral vegetation.

E. A zone practically devoid of algal vegetation on exposed rock and regularly exposed to inter-tidal drying factors.

Algae occur in damp habitats of this zone, such as fissures and shallow depressions.

F. A rudimentary zone of sporadic occurrence, only very occasionally showing a fair development. This zone is dominated and characterised by *Gelidium pristoides*.*

G. A penultimate zone dominated by either *Chaetangium ornatum*, *C. saccatum*, or both species as co-dominants.

H. The highest littoral zone dominated by *Porphyra capensis*.

Henceforth these zones will be referred to by their index letter (A zone, B zone, etc.) or by the generic name of their most characteristic algal species. The sub-littoral zone will either be referred to as such or as the A zone.

Fig. 6 shows the sequence of zones in the four regions.

Region I.—Lamberts Bay and Yzerfontein.

The algal vegetation of these localities differs from that at Melkbosch chiefly in the character of the sub-littoral zone, which is here dominated by *Laminaria pallida* instead of by *Ecklonia buccinalis*. Further, the sub-littoral zone is not extensive, due in part to the absence of the latter species.†

Ecklonia is also present, but no *Macrocystis pyrifera* was observed. Two factors may contribute to the absence of the latter species: (1) the heavy seas, (2) the limited extent of the sub-littoral vegetation which could form a barricade between *Macrocystis* and the open sea. *Ecklonia* is not common, but in the more sheltered places at Lamberts Bay it was observed forming a very narrow sub-zone on the landward side of the sub-littoral zone. Between Yzerfontein and Melkbosch there may be localities where *Laminaria* and *Ecklonia* are co-dominants in the sub-littoral zone.

Lamberts Bay.—For the most part there is little or no algal vegetation, giving the impression of extreme barrenness, although the rocky sub-stratum—Table Mountain sandstone—is not an unsuitable one for sea-

* It would be more accurate to regard the *Gelidium* "zone" as outliers of a warmer water association intruding into the *Iridaea*—and Bare—zones. Thus, strictly speaking, it is not an additional zone, but the designation "*Gelidium zone*" is here used for the sake of convenience.

† In the writer's experience, *Laminaria pallida* is always of much smaller dimensions than *Ecklonia buccinalis*, which may have a stipe length of over 20 feet, while that of *Laminaria* does not attain half this length.

weeds. The coast-line is mostly unindented, but there are protected bays in which the algal growth is both luxuriant and varied. Of the small bays examined this is particularly true of that in which the crayfish factory is situated.

The main features of the algal vegetation are summarised in Table I.

TABLE I.

THE ALGAL VEGETATION OF LAMBERTS BAY.

Zone.	Chief species.	Other species.	Remarks.
A	*Laminaria pallida*, dominant.	See p. 130.	
B Sub-zone (i)	*Champia lumbricalis*, dominant.	*Plocamium cornutum*. *P. rigidum*. Both occasional and local in distribution.	Sub-zone (i) is dense and well developed. Sub-zone (ii) is well developed in the Crayfish factory bay, but in other bays it may be represented by *Gigartina stiriata* in the upper reaches of the *Champia* sub-zone.
Sub-zone (ii)	*Gigartina radula*, *G. stiriata*, co-dominants.	*Gigartina fastigiata*. *Codium fragile*. *Gymnogongrus capensis*.	
D	*Iridaea capensis*, a characteristic and dominant species.	*Chordaria capensis*. *Cladophora* spp. *Ulva lactuca*. *Bryopsis plumosa*. *Splachnidium rugosum*. *Caulacanthus ustulatus*. Corallinaceae.	The species listed represent the zone at its richest development. *Iridaea* and *Chordaria* are of constant occurrence and extend highest upshore.
G	*Chaetangium saccatum*, dominant.	*C. ornatum*. Rare.	The dominant species is very common and forms dense and large-sized colonies.
H	*Porphyra capensis*, dominant.	..	A well-developed zone. The individuals of *Porphyra* are large and healthy.

Apart from the difference in the character of the sub-littoral zone there are two further differences to be noted in the algal vegetation of Lamberts Bay as compared with that of Melkbosch. First, both the B and D zones have a greater number of common and characteristic species. The dominant species of all the littoral zones, however, remain the same in both localities. Secondly, at both Lamberts Bay and Yzerfontein the G zone is dominated by *Chaetangium saccatum*, while at Melkbosch *C. ornatum* and *C. saccatum* are co-dominants.

Region II.—Melkbosch (see pp. 122, 128).

The chief features of the algal vegetation and its zonal sequence are summarised below.

A zone. *Ecklonia buccinalis*, dominant.

B zone. *Champia lumbricalis* } dominants.
Gigartina stiriata }
G. radula, sub-dominant. A dense zone.

D zone. *Iridaea capensis* and *Caulacanthus ustulatus* the most characteristic species.

E zone. Devoid of algal vegetation except in fissures and damp depressions.

G zone. *Chaetangium ornatum* and *C. saccatum*, co-dominant.

H zone. *Porphyra capensis*, dominant. A dense and extensive zone.

Region III.—Northern and North-Central Region of the West Coast of the Cape Peninsula.

The following localities were studied:—Mouille Point, *Three Anchor Bay, Rocklands Bay, Bantry Bay, *Camps Bay, Hout Bay, Kommetje, Slangkop. Detailed investigations were conducted at those localities marked with an asterisk.

This region is characterised by the presence of *Bifurcaria brassicaeformis* * as a common species which frequently dominates a definite littoral zone—a zone intercalated between the *Champia*—or B—zone and the *Iridaea*—or D—zone. In the other localities so far considered no *Bifurcaria brassicaeformis* was found, and although this does not prove its absence it is at least certain that it is of rare occurrence. Further careful study may bring out additional diagnostic features of Region III. The sublittoral zone is essentially the same as in Region II except that perhaps the relative frequency of *Laminaria pallida* diminishes.

Three Anchor Bay and Camps Bay.—The rocky substratum at Three Anchor Bay (as also at Rocklands Bay) consists of Malmesbury slate, that at Camps Bay of granite. In the former locality the pools are mostly small and shallow. Although rock pools are not a feature of the latter locality there are a few deep pools of good size, some of them connected with the open sea. Both localities have beaches of essentially similar topography, neither being boulder strewn and both showing much medium and gently sloping surface and also rock ledges, although rock ledges are more particularly a feature of Three Anchor Bay.

At low-water of spring tides the disposition of the vegetation of the two

* The name *Bifurcaria* (Stackhouse) was published in 1809 and so has priority over *Pycnophycus* (Kützing) which was published in 1843.

localities presents a general contrast. At Three Anchor Bay the algal vegetation is seen to be mostly confined to the kelps (*Ecklonia buccinalis*, dominant) out at sea, and to the lower reaches of the littoral area extending upwards to about the level of low-water mark of neap tides. The division of the littoral area into two is evident from a distance, not only on account of the algal vegetation of the lower reaches but also because at the latter level the rock is rendered a pale brownish-pink colour by the presence of encrusting Corallinaceae, while the uncovered rock above is greyish black in colour. Except for the sub-littoral kelps the shore has a very desolate appearance at low water of neap tides. This is due to at least four circumstances:

(1) The Bare—or E—zone is broad and thus a prominent feature, with only limpets (*Patella granularis*) inhabiting the fully exposed rock, although there are a variety of algal forms in rock pools, damp shallow depressions, and fissures.

(2) The *Chaetangium* zone is virtually absent, although scattered and isolated individuals or small groups of *C. ornatum* and less frequently of *C. saccatum* are to be found.

(3) Over considerable stretches the *Porphyra* zone is absent, although very locally it may be well developed.

(4) The promenade wall infringes on the *Porphyra* zone in some places.

From about low-water level of neap tides downwards there is a luxuriant and varied algal growth with a fair amount of variation due to different topographical features.

In contrast to Three Anchor Bay all the zones (littoral and sub-littoral) are well developed at Camps Bay. The *Chaetangium* zone is extensive, *C. saccatum* being on the whole dominant and *C. ornatum* sub-dominant. The position of this zone varies; it may occur high up and just below the *Porphyra* zone (fig. 1, Pl. II), or it may occur immediately above the D zone, or it may even intrude into the E zone. Where the two species occur together there is a definite tendency to form two sub-zones, *C. saccatum* being uppermost. The zone dominated and occupied by *Porphyra capensis* is also well developed and in places is both dense and extensive.

The Bare Zone.—This zone is a well-marked feature of both localities. Only limpets (*Patella granularis*) and an occasional *Lepadoderma africanum* inhabit the fully exposed rock. There are, however, a variety of algal forms in rock pools, damp shallow depressions, and cracks in the rock. This level of the beach presents a more desolate appearance at Camps Bay since cracks and damp shallow depressions are few. Algae from the *Iridaea* zone extend into these damper habitats of the Bare zone. The damp shallow depressions and especially the fissures are lined with encrusting

Corallinaceae. In such habitats the following species are found: *Chordaria capensis*, *Scytosiphon lomentarius*, *Cladophora Eckloni*, Corallinaceae (jointed).

The Iridaea *Zone.*—At Three Anchor Bay and on exposed rock faces and steep slopes at Camps Bay, this is an ill-defined, rarely dense, and somewhat characterless zone. The most frequent alga is *Iridaea capensis.* Other more or less constant and characteristic species of this zone are: *Caulacanthus ustulatus*, *Splachnidium rugosum*, and *Lepadoderma africanum.* At Camps Bay on rock ledges and gently sloping rock faces the vegetation is sometimes extensive and dense, especially where there are shallow water retaining depressions and numerous casts of *Gunnarea capensis* to afford an easy substratum for anchorage. Here a number of common algal species are found in addition to those named above. The chief of these are: *Porphyra capensis*; *Ulva lactuca*, *U. uncialis* *; *Bifurcaria brassicaeformis*; *Leathesia difformis*; *Gigartina radula* and *G. stiriata* are also found in this zone.

The Bifurcaria *Zone.*—This zone is not a constant feature and is often absent especially in sheltered places. Further, it is not always clearly deliminated from the zones above and below.

Bifurcaria brassicaeformis is dominant, but quite a number of other species are found growing at this level—invaders from the B zone below and the D zone above.

The Champia *Zone.*—At Three Anchor Bay this is the most extensive, best developed, and most varied of the littoral zones. The zone is also well developed at Camps Bay, but there it is less varied in character, and in sheltered places the *Iridaea* zone may be as well or even better developed. In both localities *Champia lumbricalis* is ubiquitous and for the most part dominant. In more exposed places *Champia* occupies the zone almost entirely, but *Plocamium cornutum* is also prominent. The latter species may be somewhat local in its distribution, occurring at a somewhat higher level (Camps Bay), or not infrequently it may be sufficiently common to be styled a sub-dominant, or it may even be co-dominant with *Champia*, and occasionally it is the dominant species. In more sheltered places *Gigartina stiriata* and *G. radula* are much more common, and in very sheltered places *Champia* tends to fall out completely, *G. radula* becoming very common or sub-dominant (Camps Bay). *G. radula* is less common at Three Anchor Bay than at Camps Bay. Thus on the whole *Champia lumbricalis* and *Gigartina stiriata* are the dominant species, and where they occur together *Champia* tends to dominate a sub-zone at a lower level than *Gigartina*, which dominates an upper sub-zone.

* The writer is of the opinion that careful investigation will probably show this species to be a form of *Ulva lactuca.*

Variations in relation to topographical factors are well seen at Three Anchor Bay. The densest growth occurs on vertical rock faces and on fairly steep slopes, but the greatest variety of species are found on rock ledges. On vertical faces and steep slopes *Champia* shows a higher relative frequency and may form more or less pure stands. Two other prominent species, *Plocamium cornutum* and *Pterosiphonia cloiophylla*, show a more discontinuous distribution. This is even more the case with *Botryoglossum platycarpum*, which very locally may be quite prominent. In a few instances, *Pterosiphonia cloiophylla* and *Plocamium cornutum* were observed as co-dominants forming a practically closed community.

The most complex communities at Three Anchor Bay are found on the flat rock ledges with slight damp depressions which may contain a little water. The algal vegetation, however, is not so dense as to form a more or less continuous cover. Typically the flat rock surfaces are covered with encrusting Corallinaceae over which limpets (*Patella cochlear*) are scattered at intervals (Stephenson, 1936). The shells of these limpets often bear dense tufts of *Ceramium clavulatum* and around the rim of many shells there is a narrow zone of small algal growth which according to Dr. Papenfuss consists of small fronds of *Herposiphonia Heringii*. In between the limpets are a number of algal species, the absolute frequency tending to increase towards the sea, *Champia* usually dominating and *Gigartina stiriata* being the next most common species.

The following species of this zone also deserve mention: *Gymnogongrus dilatatus*, *G. glomeratus*, *G. capensis*, *Ceramium diaphanum*, *Cladophora* spp., *Cheilosporium palinatum*. Also individuals of the characteristic species of the *Iridaea* zone.

Rock Pools at Three Anchor Bay.—The commonest rock pool species are *Ulva lactuca* and *Bifurcaria brassicaeformis*. The former is dominant in the large upper pools. Corallinaceae and *Chordaria capensis* are also common species. The following are also present: *Scytosiphon lomentarius* (larger forms), *Grateloupia filicina*, *Dicurella flabellata* (stunted forms), *Enteromorpha*.

The Algal Vegetation of Camps Bay compared with Three Anchor Bay.—Taken as a whole the vegetation at Camps Bay is not less dense than at Three Anchor Bay, but, whereas in the latter locality the densest and most varied vegetation is found in the B zone, in the former the D zone is often dense and better developed. The B zone at Camps Bay is less varied and has fewer common species. The G and H zones are well developed at Camps Bay, in which respect it presents the most marked contrast to Three Anchor Bay. The *Porphyra* zone, however, is not as well developed as at Melkbosch, although the individual plants—as in the case of *Chaetangium saccatum*—attain considerable dimensions.

Region IV.—Southern End of the West Coast of the Cape Peninsula.

Observations were made in the following localities, those marked with an asterisk being subjected to more careful investigations: Mast Bay, Boys Kraal to the Wreck, *Plaatboom Point to south end of Rheboksdam Bay, *southern end of Rheboksdam Bay to Maclear Beach, Maclear Beach to the Cape of Good Hope (fig. 2).

The rocky substratum of this region is Table Mountain sandstone.

Region IV is characterised by the presence of *Gelidium pristoides* as a common littoral species on rock ledges, rock faces, and especially the tube colonies of *Gunnarea capensis*. The writer has found this alga farther north at Dassen Island, Mouille Point, and at Kommetje. At Dassen Island and Mouille Point this species shows stunted growth and is local in its distribution. This is especially the case at the latter locality where it is rare. At Kommetje * the *Gelidium pristoides* is not stunted but of fair size. In the writer's experience, however, it is confined in this locality to the promontary opposite the hotel where, although the distribution is local, it shows a dense growth where it occurs. It is mostly found on the tube colonies of *Gunnarea capensis*, in small narrow kloofs, and on the landward side of rocks a little out to sea. Around much of this promontory the sea is shallow.

Gelidium pristoides can hardly be said to form and dominate a definite zone, since it is absent for considerable stretches of coast, and also its vertical situation in the littoral area varies. This may be related to the character of the substratum, for the species often shows the highest absolute frequency on the colonies of cemented coarse-grained sand constructed by *Gunnarea capensis*. In places, however, it dominates over short distances a level of the inter-tidal region corresponding to its vertical position on the east coast of the Cape Peninsula. This and especially the fact that the southern end of the west coast of the Peninsula is the beginning of the continuous range of distribution of the species form the basis for the separation of this region from Region III.† The influence of warmer seas in this region is also seen in the abundance of *Hypnea spicifera*—essentially a warm-water species—in the lowest littoral zone at Rheboksdam Bay. Of the localities studied, however, Rheboksdam Bay is peculiar in this respect.

Mast Bay to Boys Kraal and Platboom Point to the Southern End of Maclear Beach.—The algal vegetation of these localities is essentially

* At Kommetje the rock is Table Mountain Sandstone.

† North of Mast Bay there is a long stretch of coast which has not been examined, and further investigation may show that the northern limit of Region IV, characterised by the common occurrence of normal-sized *Gelidium pristoides*, lies much nearer to Kommetje than the data at present available would indicate.

similar excepting the lowest littoral zone, the character of which at Rheboksdam Bay differs from that in the other localities (see Table II).

TABLE II.

THE LOWEST LITTORAL ZONE OF REGION IV.

	Rheboksdam Bay.	Mast Bay to Boys Kraal. Southern end of Rheboksdam Bay to southern end of Maclear Beach.
Chief species.	*Hypnea spicifera.* *Gymnogongrus vermicularis.* *Champia lumbricalis.*	*Champia lumbricalis*, *Gigartina stiriata*, dominants.
Other species	*Gymnogongrus capensis.* *G. dilatatus.* *Pterosiphonia cloiophylla.* *Chondria capensis.* *Gigartina stiriata.* *G. radula.* *Plocamium cornutum* (locally very dense).	*Gigartina radula.* *Plocamium cornutum.* *Pterosiphonia cloiophylla.* *Hypnea spicifera.* *Gymnogongrus capensis.*
Remarks .	As the vegetation varies a good deal it is somewhat difficult to define the dominants with certainty. Either of the first two "Chief species" may be dominant, or they may be co-dominants. *Champia* is dominant in some places. Where *Hypnea* and *Champia* occur together, the former tends to extend below the latter, *Champia* dominating the upper sub-zone.	Not infrequently there is a differentiation into a lower subzone dominated by *Champia lumbricalis* and an upper subzone dominated by species of *Gigartina*, especially *G. stiriata*. *Plocamium cornutum*, *Pterosiphonia*, and *Gymnogongrus capensis* are very common in some parts and may not only be dominant but may practically exclude other species. The first two often occur in association, the former usually dominant and the latter subdominant.

Table III summarises the principal features of the algal vegetation from Mast Bay to Boys Kraal and Platboom Point to the southern end of Maclear Beach.

One very prominent feature of the rock-pool vegetation at Mast Bay deserves mention. *Schizymenia undulata* is very abundant, and in some of the higher pools practically excludes all other species. These pools allow a free inward and outward flow of sea-water.

At the southern end of Maclear Beach, a more or less flat beach with jutting rocks and boulders, two zones are very prominent and luxuriant:—

(1) An extensive sub-littoral zone dominated by *Ecklonia buccinalis*.

(2) An extensive zone of luxuriant *Bifurcaria brassicaeformis*.

TABLE III.

THE ALGAL VEGETATION OF MAST BAY TO BOYS KRAAL, AND PLATBOOM POINT TO SOUTHERN END OF MACLEAR BEACH.

Zone.	Chief species.	Other species.	Remarks.
A	*Ecklonia buccinalis*, dominant.	*Laminaria pallida.*	This zone is absent from southern end of Rheboksdam Bay.
B	..	..	See Table II.
C	*Bifurcaria brassicaeformis*, dominant.	..	Vertical situation not always well defined. The zone is well developed from Platboom Point to the southern end of Maclear Beach. Between Mast Bay and Boys Kraal it is absent for considerable intervals of coast.
D	*Iridaea capensis*, most characteristic species.	*Caulacanthus ustulatus.* *Splachnidium rugosum.* *Ulva* spp. *Cladophora* spp. *Gigartina radula.* *Gelidium pristoides.* *Chylocladia capensis.* *Chordaria capensis.* Corallinaceae, esp. *Cheilosporium palinatum.*	Poorly defined and frequently absent. At Mast Bay, large-sized individuals of *Splachnidium rugosum* often form nearly pure stands.
F	*Gelidium pristoides.*	..	See p. 138.
G	*Chaetangium ornatum*, dominant.	*C. saccatum.* In places this is sub-dominant.	Poorly developed and mostly absent, but locally it may show a high absolute frequency.
H	*Porphyra capensis*, dominant.	..	Poorly developed and mostly absent, but better developed than the G zone.

Langebaan and Dassen Island.

Geographically both of these localities fall into the tentatively defined Region I, but ecologically and floristically they must be considered apart from Region I and apart from one another.

Langebaan.—Brief reference has already been made to Saldanha (p. 121).

Langebaan is situated on the landward coast of the lagoon and about one and a half miles south of the opening to the sea (fig. 1). The temperature conditions at Saldanha are high for the west coast, and although there are no temperature data available for Langebaan it is reasonable to expect that still higher temperatures prevail there, due to the shallowness of the water and to the greater protection from the open sea. The algal flora affords indirect evidence for this view.

The higher sea-temperature conditions make this region one of considerable interest, but unfortunately the substrate is mostly sand, there being comparatively little accessible rocky coast. Hitherto only the vegetation of rocky coasts has been considered, and so no detailed account of the vegetation is given, attention being directed to some of the more outstanding and interesting features.

In many parts of the lagoon * there are extensive and dense beds of completely submerged vegetation rooted in sand. Dredgings were made with a six-pronged anchor at depths varying from 3 to 7 feet, which showed the beds to consist of large-sized, richly branched *Gracilaria confervoides*. Along the entire sandy beach of the landward coast, from Langebaan northwards to the latitude of the open sea, this alga is thrown up in very large quantities, forming in places a dense and extensive bank 3 to 4 feet high. As would be expected, these submerged beds of *Gracilaria* afford shelter for large numbers of small animals, including fish and especially sea cucumbers.

The occurrence of *Zostera capensis* also deserves mention (see Appendix I).

At Langebaan the kelp association is absent from the sub-littoral, but both *Laminaria* and *Ecklonia* occur in fair quantity around the islands towards the open sea. In the direction of Saldanha (Hoedjes Bay), and away from the open sea, the kelps again tend to disappear, but not as completely as they do down the lagoon in the direction of Langebaan. At Hoedjes Bay, *Ecklonia buccinalis* is dominant and is practically the only kelp present. There is not, however, a great deal of it and the individuals are stunted.

The littoral vegetation is very limited both as regards variety of species and number of individuals. In most parts there are few or no littoral algae, but, where found, the following sequence obtains:—

(1) *Ulva lactuca*; small individuals of *Iridaea capensis*; *Codium fragile*; *Caulacanthus ustulatus*; at the upper limits, a few individuals of *Splachnidium rugosum*. This corresponds to the D zone.

* Chiefly near the shore and near the large sandbank about three-quarters of a mile south of the hotel.

(2) *Chaetangium ornatum.* In places this shows a dense and extensive growth. This corresponds to the G zone.

(3) *Porphyra capensis.* The distribution of this species is limited and it was nowhere observed to form a dense and extensive zone. The individuals are of small size. At Hoedjes Bay the species is more abundant and the individuals larger, but here also the zone is never dense or extensive. This corresponds to the H zone.

About half a mile south of Langebaan, on the landward side, a few large-sized individuals of *Sargassum* * were found growing on rock along with *Codium fragile*, at the level of the lowest littoral zone.

Dassen Island.—The island is of granite. The sub-littoral zone is well developed, *Ecklonia buccinalis* being dominant. *Macrocystis pyrifera* is fairly common. The littoral vegetation is neither dense nor varied, especially on the landward side. This may in part be associated with the presence of the Jackass Penguin (*Spheniscus demersus*), thousands of which densely populate the island. These birds are, of course, piscivorous, but they tramp and rest on the rocks although preferring the small sandy stretches for approaching the sea. Certainly the water of many of the rock pools is badly fouled, and in these pools *Enteromorpha compressa* is very abundant.

The following algae were observed:—

Champia lumbricalis. (Atlantic coast.)

Iridaea capensis. Large-sized individuals.

Gelidium pristoides. (Atlantic coast.) Stunted. Occurring in small isolated cushions on exposed rock at mid-tide level, and also in shallow rock pools.

Caulacanthus ustulatus. Well developed and frequently associated with *Gelidium pristoides.*

Chaetangium saccatum. A few colonies found on landward coast. Smaller than the individuals observed at Yzerfontein.

Porphyra capensis.

Discussion.

The Associations of the West Coast.

It was deemed best to deal with the algal vegetation of South African coasts in terms of zonal sequence instead of in terms of algal associations. The chief reason for this is that there are practically no published accounts of the algal vegetation,† and so there is no background of knowledge con-

* *Sargassum* (*S. incisifolium*) was recorded by Barton (1893) from Saldanha Bay. There has been no record since and no previous record for Langebaan.

† "The Distribution of the Sea-weeds of the Cape Peninsula" (Levyns, 1924);

cerning the general features of zonation such as is the case for the colder European coasts. The definition and delimitation of the various algal communities may, however, prove more suitable for intensive ecological work dealing with single localities and special problems. Consequently, it may prove useful and instructive to indicate the chief plant associations of rocky coasts occuring in the region dealt with in this paper.

(a) *The Kelp Association.*—This occurs beyond low-tide level and is never exposed. The kelps form the upper stratum of the association. The lower strata have not been investigated. The dominant species are *Ecklonia buccinalis* and *Laminaria pallida*, the latter dominating in the colder waters (*Laminaria* consociation), where smaller communities are formed, as *Laminaria* does not attain the stature of *Ecklonia*. *Macrocystis pyrifera* is a subordinate, characteristic, and exclusive species. It usually forms societies or clans within a pallisade of *Ecklonia*, which protects it from the full force of the sea. In sheltered situations it grows independently of *Ecklonia*. This is clearly seen in the north-western end of Hout Bay, where there is almost a bay within a bay, affording sufficiently sheltered conditions for *Macrocystis* to extend a good way out to sea beyond *Ecklonia* and *Laminaria*. *Macrocystis* was not observed along the coast farther north than Melkbosch, although it was found growing around Dassen Island. Its absence from the localities visited may be due to local factors (heavy seas), but it has only been recorded in South Africa in the region of the Cape Peninsula, although it is widely distributed around the Antarctic, occurs in Tasmania, along most of the coasts of New Zealand, along the entire extra-tropical west coast of North and South America, and extends into the southern hemisphere tropics almost to the equator along the west coast of South America (see map—fig. 12—Setchell, 1935). The most characteristic epiphytes of this association are: *Carpoblepharis flaccida*, *Suhria vittata*, and *Polysiphonia virgata*.

(b) *The* Champia *Association.*—This occurs at low-tide level of spring tides and is therefore not exposed at neap tides. The dominant species are *Champia lumbricalis, Gigartina stiriata, Plocamium cornutum, Pterosiphonia cloiophylla*, and *Gigartina radula*. *Champia* is invariably present and is the most usual dominant. It flourishes best in more exposed places

"Marine Algæ of the Cape Peninsula" (Delf, 1921); "Sea Weeds of the Cape Peninsula" (Levyns, 1929).

Of these, the first is the most important. It is concerned essentially with a comparison between the algal floras of Kalk Bay to Muizenberg on the east coast of the Peninsula and Kommetje on the west coast. Although more ecological in spirit than any previous contribution, its main interest remains floristic. The second is in no way a critical contribution, but the paper contains some interesting observations on a few individual species. The third is a note and adds nothing of significance to the paper of 1924.

and tends to disappear in very protected situations. In more exposed situations *Plocamium cornutum* is usually present along with *Champia*, the former species being co-dominant or sub-dominant and rarely dominant. It tends, however, to form pure societies in the *Champia* zone. *Pterosiphonia cloiophylla* is local in its distribution, but it sometimes occurs as co-dominant with *Plocamium*, the two species forming a dense, closed society. In less exposed positions *Gigartina stiriata* is co-dominant with *Champia*, this rôle being sometimes taken by *G. radula* when *G. stiriata* is sub-dominant. *Champia* and *Gigartina* tend to form distinct consociations, the *Champetum* occurring at a lower level than the *Gigartinetum*.

The association described above is characteristic of sloping rock surfaces and rock faces of the west coast localities studied with the exception of Rheboksdam Bay. Insufficient observations have been made to give a general account of the west coast rock ledge vegetation at low-tide level.

The vegetation at low-tide level at Rheboksdam Bay is characterised by the abundance of *Hypnea spicifera* which often here assumes the rôle of dominant. Since this has not been observed in any other west coast locality, and since *Hypnea spicifera* is essentially a warm-water species, it has not been included as a dominant species of the *Champia* association.

(c) *The* Bifurcaria *Association.*—This community is usually occupied almost entirely by *Bifurcaria brassicaeformis*. The vegetative growth is usually dense, and due to the rhizome-like creeping organs of the dominant species most other algae are crowded out.

This association is not confined to the west coast, and will be dealt with more fully in a subsequent paper.

(d) *The* Iridaea *Association.*—This has less character than the other associations of the west coast. It is found in both exposed and sheltered situations, but is most extensive in sheltered places where the vegetation is denser and a greater variety of species is present. *Iridaea capensis* is the most constant and characteristic alga and may be termed the dominant species. It shows stunted growth in exposed places, but attains much larger dimensions where the sea has less force. *Caulacanthus ustulatus* is sub-dominant or sometimes dominant. It forms dense cushions usually about half to one inch in diameter.

Splachnidium rugosum and *Ulva* spp. are constant species of this association.

(e) *The* Gelidium *Association.*—*Gelidium pristoides* is dominant. This association will be dealt with in a subsequent paper as it essentially belongs to the warmer waters.

(f) *The* Chaetangium *Association.*—There are two dominant species—*Chaetangium saccatum* and *C. ornatum*. Only occasionally do other species occur in this association, and more particularly an occasional *Porphyra*.

The inter-tidal level of this association varies somewhat, but it is usually situated above the Bare zone and below the *Porphyra* zone, although the latter does not usually overlap with this association, and when it does the overlapping is slight. The *Chaetangium* association may, however, occur at a level immediately above the *Iridaea* association, and thus in the lower part of the Bare zone.

The two species of *Chaetangium* tend to dominate two distinct consociations. That dominated by *C. saccatum* is more characteristic of the colder waters and of a granitic substratum; that dominated by *C. ornatum* definitely favours somewhat warmer seas and occurs also along the whole of the east coast of the Cape Peninsula.

Where these species occur together as co-dominants, *C. saccatum* tends to dominate a consociation at a somewhat higher inter-tidal level than *C. ornatum*.*

(g) *The* Porphyra *Association.*—This association is dominated by *Porphyra capensis*, and only occasionally are individuals of other species present. This association is subject to the greatest amount of exposure to the air, and its upward extension is substantially limited by the high-water mark of neap tides, for *Porphyra capensis* is unable to endure more than eight to nine hours' exposure at a time without becoming very pale, stunted, and of unhealthy appearance. Although this association is usually situated high up in the littoral area, it sometimes extends downwards to mid-tidal level, especially in damp places.

The association is not confined to the west coast, but is widely distributed along the coasts of South Africa. *Porphyra*, however, is essentially a cold-water alga, since the association is more extensive and of greater absolute frequency on the west coast, where also the individual plants are of a decidedly larger average size than in the warmer seas.

On the west coast the association persists throughout the year without much change, although it is more extensive in winter and spring. In more southerly localities during early and midsummer the plants in the upper regions of the zone become a pale yellow or even colourless (Llandudno) and die away.

Changes in the Algal Flora and Vegetation of the West Coast in relation to Environmental Conditions.

Temperature is the master factor, and the principal changes that take place in a north to south direction are due to a gradient of increasing sea temperature. These changes have been crystallised out and indicated, in the sub-division of the west coast localities studied into four regions.

* The facts here presented relating to the ecology of *Chaetangium saccatum* are at variance with the data given by Martin (Martin, 1936).

Fig. 6 summarises these changes. The conclusions in relation to temperature effects, implicit in the definition of the four regions, are based on a wider study than is represented by this paper, and fuller evidence will be subsequently presented. Here some of the most salient changes only will be recounted:

1. The decreasing abundance of *Laminaria pallida* and to a lesser extent *Chaetangium saccatum*, with increasing sea temperature.

2. The appearance as common species with increasing sea temperature, first of *Bifurcaria brassicaeformis* and later of *Gelidium pristoides*.

3. The decreasing luxuriance of the *Porphyra* association with increase in temperature.

The constant features of the algal vegetation of the west coast have been dealt with in relation to Melkbosch (p. 129). They are also made evident in fig. 6.

Attention may be called to one further feature—the prominence of Rhodophyceae in the littoral area. Phaeophyceae are not a prominent feature above low-water mark of spring tides. *Bifurcaria brassicaeformis* is the only "brown alga" which here dominates a zone or association. Otherwise, *Splachnidium rugosum*, which has a wider geographical range, is the only constant and common species. The prominence of Rhodophyceae at the Cape was noted by Murray in his statistical analysis of the marine floras of the Indian Ocean, the warm Atlantic and South Africa. He points out that: "One expects to find fewer species to the genus at the Cape than in the tropical floras, but one hardly expects to find that the genera of Florideae at the Cape are by 5 more numerous than in the warm Atlantic, and by 15 more than in the Indian Ocean. There (are) no less than 95 genera of Florideae at the Cape, with 295 species, while the 90 of the warm Atlantic contain nearly 200 more species" (Murray, 1893). Rhodophyceae are not only the dominant forms in all the zones other than the *Bifurcaria* zone, but for the most part they are also the common species.

Although temperature is the master factor, other factors also exercise an influence on algal vegetation. The most important of these are: (1) the character of the substratum; (2) the degree of exposure to heavy seas; (3) the topography of the coast—whether the beach consists of strewn boulders or whether there are many vertical rock faces, steep slopes, or rock ledges. The first of these is less important than the other two.

The chief difference in the character of the substratum lies between granite on the one hand and Table Mountain Sandstone (T.M.S.) and Malmesbury shales and slates on the other. Granite is reputed to give a less satisfactory surface for the attachment of marine algae (Delf and Michell, 1921; Levyns, 1924), and certainly between Bakoven and Llan-

dudno, where most of the shore is of granite, there is but limited littoral algal vegetation. This, however, is frequently due to the character of the beach, which consists of strewn large and small boulders (granite and T.M.S.)—a type of substratum which always bears a limited growth of algae. Under comparable conditions of moderate shelter from the full force of the sea and with a beach of gently sloping surfaces and rock ledges, granite has as dense an algal vegetation as T.M.S. or Malmesbury. In this connection also, the inter-relationships existing between tube-building marine worms and algae is of importance. It seems probable that in exposed situations granite affords a less suitable substratum than the other rock formations. Also the topographical character of the granite beaches (see below) is usually less favourable. A granitic substratum, however, seems definitely to favour *Chaetangium saccatum*.

The degree of exposure affects the lower zones to a greater extent than the upper, although they are also affected. Thus *Porphyra capensis* flourishes best in situations which are not too exposed to the full force of the sea. In the sub-littoral zone *Macrocystis pyrifera* grows best in sheltered situations. In the littoral zone, *Champia lumbricalis* flourishes best in more exposed situations, *Gigartina stiriata* and especially *G. radula* in more sheltered places. *Bifurcaria brassicaeformis* does not flourish in a decidedly sheltered situation. The *Iridaea* zone is best developed in sheltered places, and also in such places *Porphyra* extends lower into the littoral area towards the mid-tidal region.

The topography of the beach is of decided importance and is closely linked with the exposure factor. The most varied flora is found on rock ledges, but in the lowest littoral zone the densest vegetation is frequently found on vertical faces and steep slopes. The algal vegetation is least dense on a beach of small boulders.

Summary.

1. This paper deals chiefly with the ecology of rocky habitats exposed by neap and spring tides, and with the chief features of the sub-littoral zone, in so far as they are observable, at the surface of the sea.

2. Northwards from Capetown to Lamberts Bay the coastal waters show a general fall in temperature. Because of local factors Saldanha and Langebaan have relatively high sea temperatures.

3. The existence of currents in an opposite direction to the main Benguela current, and the upwelling of colder waters due to wind action, cause the temperatures around Robben and Dassen Islands to be higher than along the coasts of the corresponding mainland.

4. The tidal range of the region investigated is about 5 feet.

5. The algal vegetation of Melkbosch is considered in some detail as a basis for the study of the algal vegetation of the entire region investigated.

6. Except at Lamberts Bay and Yzerfontein, the sub-littoral zone is dominated by *Ecklonia buccinalis*. *Laminaria pallida* and *Macrocystis pyrifera* are also prominent species. At Lamberts Bay and Yzerfontein *Laminaria pallida* is dominant.

7. *Champia lumbricalis* is the most constant species and the most frequent dominant in the lowest littoral zone. Except at Rheboksdam Bay, *Gigartina radula* and *G. stiriata* are co-dominant with, or sub-dominant to, *Champia*. These rôles are usually taken by *G. stiriata*.

8. At Rheboksdam Bay, although *Champia* is present, *Hypnea spicifera* and *Gymnogongrus vermicularis* are on the whole the commonest species.

9. The relative frequency of *Champia* and the two species of *Gigartina* is influenced by the degree of exposure to rough seas.

10. *Champia* on the one hand and *Gigartina* on the other tend to form two separate sub-zones, the lower of which is dominated by *Champia*.

11. The rock-ledge vegetation of the B zone is more complex than the vegetation of vertical rock faces and steep slopes.

12. The B zone is not exposed at neap tide.

13. The rocky substratum at the level of the lowest zone of littoral vegetation is mostly covered by encrusting Corallinaceae.

14. Along the west coast of the Cape Peninsula, the B zone is usually succeeded by a zone of *Bifurcaria brassicaeformis*. This species has not been found north of the Peninsula.

15. Next comes a narrow and usually ill-defined zone chiefly characterised by *Iridaea capensis* and *Caulacanthus ustulatus*. *Splachnidium rugosum* is also found at this level. This zone is found throughout the whole stretch of coast investigated.

16. Above the *Iridaea* zone comes a relatively bare level of the littoral area. Save for the encrusting *Lepadoderma africanum* this level is devoid of algae except in damp depressions, rock pools, and fissures in the rock. Limpets (*Patella granularis*) are the chief inhabitants of this zone.

17. The damp depressions and fissures of the Bare zone are invaded by algae both from above and from below. Chiefly the invaders are from below. The most common species of these habitats are *Caulacanthus ustulatus* and encrusting Corallinaceae.

18. The penultimate zone is dominated by *Chaetangium ornatum*, *C. saccatum*, or by both species as co-dominants. *C. saccatum* is more characteristic of colder waters; *C. ornatum* of warmer waters.

19. The uppermost zone is dominated and almost exclusively occupied

by *Porphyra capensis*. This zone persists throughout the year with relatively little seasonal change and is covered by every tide. The amount of seasonal change increases with increase in sea temperature.

20. The localities studied with the exception of Langebaan and Dassen Island, have been grouped into four *tentative* regions.

21. Region I includes Lamberts Bay and Yzerfontein. In these localities the sub-littoral zone is dominated by *Laminaria*.

22. Melkbosch constitutes Region II. This locality shows all the features constant to the littoral area throughout the four regions.

23. Region III comprises the northern and north-central parts of the west coast of the Cape Peninsula. It is characterised by the presence of *Bifurcaria brassicaeformis* as a common species which frequently dominates a definite inter-tidal level.

24. Region IV is the southern end of the west coast of the Cape Peninsula. Here normal-sized *Gelidium pristoides* becomes a common species, and this region is the beginning of its continuous range of distribution. The local abundance of *Hypnea spicifera* at Rheboksdam Bay affords further evidence of the influence of higher sea temperatures.

25. *Gelidium pristoides* was found farther north on the west coast of Dassen Island, at Mouille Point, and very locally at Kommetje. At the first two localities the plant is stunted.

26. Relatively high temperatures prevail at Langebaan, and this is the only west coast locality where the typical warm-water alga *Sargassum* was found growing.

27. That higher sea temperatures prevail around Dassen Island as compared with the opposite mainland is indicated by the dominance of *Ecklonia* in the sub-littoral zone instead of *Laminaria* as at Yzerfontein.

28. The most important algal associations of the west coast are delimited and their principal characteristics described.

29. Temperature is the master factor determining the changes in flora and vegetation along the west coast. Locally other factors also play a part, particularly the degree of exposure to heavy seas and the topography of the coast. The character of the rocky substratum is of less importance.

30. A granitic substratum definitely favours *Chaetangium saccatum*.

31. *Champia lumbricalis* and *Bifurcaria brassicaeformis* do not flourish in very sheltered situations, while the more protected places favour *Macrocystis pyrifera* and *Gigartina radula*. *Macrocystis* is most typically found behind a protecting pallisade of *Ecklonia*.

32. Except for one narrow zone along the west coast of the Cape Peninsula (the *Bifurcaria* zone) and the common occurrence of *Splachnidium rugosum* throughout the four regions, both the dominant and common species of the entire littoral area are *Rhodophyceae*.

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Appendix I.

The Occurrence of Zostera capensis *at Langebaan.*

The *Zostera* collected at Langebaan was identified as *Z. capensis*.

Small beds of *Zostera* were found rooting in sand in protected bays along the landward coast south of Langebaan. The beds seen were not dense and occurred at a depth of 3 to 4 feet. No *Zostera* was dredged up from the beds of *Gracilaria confervoides* occurring in deeper water, but much of it was found thrown up on the landward beach in the vicinity of Langebaan, which suggests the presence of more extensive beds of the species which were not observed. The amount of *Zostera* thrown up as flotsam, however, was much less than that of *Gracilaria*.

This record is of interest since *Zostera* has not previously been recorded from the west coast of South Africa (see Setchell, 1935, fig. 9), although it occurs along the south and south-east coasts. The writer was informed by Professor Adamson that the late Professor Moss found *Zostera* growing near Muizenberg on the east coast of the Peninsula about eleven years ago, but since then, as a result of drainage operations, it has disappeared from the locality.

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Part of the sub-littoral kelp vegetation at Melkbosch.

Macrocystis pyrifera (A) is shown within a pallisade of *Ecklonia buccinalis* and *Laminaria pallida* (B).

FIG. 1.—*Porphyra capensis* (above) and *Chaetangium saccatum* (below) on a granite substratum at Camps Bay.

FIG. 2.—A part of the *Porphyra* zone at Melkbosch.

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CONTRIBUTIONS TO OUR KNOWLEDGE OF THE FRESHWATER ALGAE OF AFRICA.

13. *Algae from the Belfast Pan, Transvaal.**

By F. E. Fritsch and F. Rich.

(Communicated by E. L. Stephens.)

(With 31 figures in the Text.)

(Read March 17, 1937.)

A. Introduction.

The Belfast Pan † is situated in the Highveld of the Transvaal, some distance from the village of Belfast, and about 120 miles due east of Pretoria. The Pan lies in a depression on the top of a "kopje" at an elevation of approximately 6500 feet above sea-level; it is roughly circular in shape and is about 100 yards in diameter, when full of water. Belfast is nearly 50 miles distant from the Pan at Weltevreden West, from which collections of algae have been described by one of us (Rich, 1932). Samples were collected by Dr. E. M. Doidge from the Pan at Belfast in November 1909, and again in October 1913, while further collections were made in January 1924. All of these have been taken into consideration in the subsequent matter.

During the years when the collections were made the Pan apparently never dried up completely, though the depth of water tended to be inconsiderable (2 to 3 feet) even after the spring rains when the samples were gathered. The Pan at these times was filled with a dense mass of macrophytic growth, comprising Cyperaceae growing round the margin, with *Limnanthemum thunbergianum* in the deeper water, as well as a quantity of *Utricularia* and *Nitella*. The sheet of water is exposed to direct sunlight.

The algal vegetation consists in the main of unicellular and colonial forms, which are present in great abundance, while filamentous forms are relatively scarce. The bulk of the unicellular forms are Desmids, of which numerous species are present, though some of these are only scantily represented. The great wealth of forms present, as well as the marked complexity and relative scarcity of some of them, is responsible for the

* From the Department of Botany, Queen Mary College, University of London. A considerable part of this work was performed with the help of a grant to the second author from the Carnegie Corporation for the Advancement of Research, made through the Research Grant Board of the Union of South Africa.

† For the meaning of "pan" see Rich, 1935, p. 107.

fact that completion of their investigation has been so long delayed. Even so, although the ensuing list gives a fair indication of the Algae that are present in the Pan, it cannot be regarded as exhaustive, several forms having had to be ignored owing to scanty representation or imperfect preservation.

Included in the list are 143 species of Conjugales, 29 other Chlorophyceae, 5 Xanthophyceae, 8 Diatoms, and 19 Myxophyceae. Fourteen new species are described, and 25 new varieties, all of which are among the Desmids; 6 of the new species and 4 varieties belong to *Euastrum*. A considerable number of the Desmids are cosmopolitan species, although diverse of these are represented by new varieties or forms. Quite a number, however, are, at present, known only from Africa, viz. *Closterium Knysnanum*, *Micrasterias crux-melitensis* var. *aequalis*, *Cosmarium asymmetricum*, *C. Hammeri* var. *africanum*, *C. pappekuilense*, *C. pseudo-sulcatum*, *C. Stephensii*, *C. sub-humile*, *Xanthidium sansibarense* and *Arthrodesmus bifidus* var. *inaequispinosus*. *Staurastrum rectangulare* has hitherto been recorded only from Australia, while *Cosmarium lobatum*, *Staurastrum stelliferum*, as well as *Bulbochaete horrida*, were previously known only from South America; *Cosmarium maximum*, already recorded from Africa, is likewise reported only from this continent and South America. A number of the species and varieties listed have previously been found only in Asia, or are known only from Asia and Africa; these are: *Euastrum pulcherrimum*, *Cosmarium decoratum*, *C. multiordinatum* var. *bhurmense*, *Staurastrum subtrifurcatum* var. *major*, *S. unguiferum* and *S. Zahlbruckneri*, as well as *Oedogonium bengalense*. Apart from those already mentioned, a number of the Desmids recorded are known in the main only from the Southern Hemisphere and immediately adjacent regions, viz. *Euastrum praemorsum*, *E. quadriceps*, *Micrasterias tropica*, *Cosmarium pseudopachydermum*, *Arthrodesmus mucronulatus* and *Phymatodocis irregulare*. A few show a similar distribution, though occurring also in North America; these are *Pleurotaenium tessellatum*, *Euastrum evolutum*,* *Cosmarium favum*,* *Staurastrum americanum* * and *S. longiradiatum*, those marked with an asterisk being known only from Africa and America.

On the whole, therefore, the algal flora as regards the Desmids includes a very distinct southern element. This is even more marked when one takes into consideration the fact that a certain number of the species of wider distribution have been found most commonly in the southern hemisphere and evidently have their chief centre of distribution there.

A striking feature of the flora is the large number of new forms of Desmids and the high degree of complexity attained by many of them. As far as we are aware, the Pan is supplied solely by spring- and rain-water and thus constitutes an isolated piece of water. From this point of view it is of interest that a large number of the Desmids present deviate in some

slight particular from the forms hitherto described, and that a considerable number of the new species appear as variants of well-known types. It is not possible to say in the present state of our knowledge whether this can be explained as due to variation in individuals, introduced into the pool, under the influence of the special habitat-conditions obtaining there. The large percentage of new forms, however, appears significant.

The great scarcity of *Pediastrum* and *Scenedesmus* and the absence of *Coelastrum* and of Ulotrichales in what would seem to be a favourable environment is noteworthy. Zygnemaceae are not well represented, while Oedogionales are present in appreciable numbers. Filamentous Desmids are common.

Some forty of the species present exhibited sexual reproduction, and the zygospores of a number of the Desmids recorded are described for the first time. The material was not, however, quite so striking in this respect as that examined from Old N'gamo in Southern Rhodesia (Rich, 1935), when, moreover, all the samples were collected on a single day. It is noticeable that only three of the species of *Staurastrum* were found with zygospores. The bulk of the fruiting Oedogoniaceae were contained in the sample collected in January 1924.

The numbers for the samples cited in the ensuing list are those of the Herbarium, Department of Agriculture, Pretoria. These are as follows:—

Nos. 72 and 75, collected November 1909.

Nos. 6 *b* and 7, collected 9th October 1913.

No. 1134, collected 22nd January 1924. (Amongst *Utricularia*, etc.)

No. 1136 *a*, *b* and *c*, collected 22nd January 1924. (Gelatinous masses stripped from the stems of Cyperaceae.)

No. 1137, collected 22nd January 1924. (Forming a dense slimy mass in the warm shallow waters near the edge of the Pan.)

We are indebted to Professor E. J. Salisbury, F.R.S., for some of the drawings of the new species which were made many years ago while he was a member of the staff of the Botanical Department of Queen Mary College.

B. Systematic Enumeration of the Species Observed.*

CLASS I. CHLOROPHYCEAE (ISOKONTAE).

Order VOLVOCALES.

Family CHLAMYDOMONADACEAE.

Genus Stephanoon Schewiakoff.

Stephanoon Wallichii Wille (= *Eudorina Wallichii* Lemmermann; Fritsch, 1918, p. 492); Rich, 1932, p. 239, fig. 1, *C*.

Colonies composed of two tiers of four cells. Diam. cell., ca. 16 μ

* The system of classification followed is that of Fritsch (1935).

(6 *b*, 75). Previously recorded from the Orange Free State, Lake Naivasha and S. Rhodesia.

Family TETRASPORACEAE.

Genus Schizochlamys A. Braun.

Schizochlamys gelatinosa A. Br.

Diam. cell., 7–11 μ (72, 75, 1136 *b*). Discarded membranes very noticeable.

Family PALMELLACEAE.

Genus Asterococcus Scherffel.

Asterococcus superbus (Cienk.) Scherffel, 1908, p. 762 (= *Gloeocystis infusionum* W. and G. S. West).

Diam. cell., 18–23 μ (6 *b*). Previously recorded for S. Rhodesia.

Genus Gloeocystis Naegeli.

Gloeocystis gigas (Kütz.) Lagerh.; Smith, 1924, Pl. VII, fig. 1.

Cells up to 23 μ in diameter (6 *b*, 72, 1136 *c*, 1137). Previously recorded for East-African Lakes and S. Rhodesia.

Genus Sphaerocystis Chodat.

Sphaerocystis Schroeteri Chod.

Diam. cell., 11–14 μ (6 *b*, 72). Frequently recorded for S. Africa.

Family CHLORODENDRACEAE.

Genus Hormotila Borzi.

A form resembling *Hormotila tropicus* W. and G. S. West (1907, p. 227, Pl. XI, fig. 21) was found in samples 1136 *a* and *b*, but was not present in sufficient quantity, or sufficiently well preserved, to make a certain identification possible. The elliptical cells were 20–30 μ long, and were borne at the ends of indistinctly lamellose mucilage stalks with an irregular margin.

Order CHLOROCOCCALES.

Family CHLOROCOCCACEAE.

Genus Characium A. Braun.

Characium cerasiforme Eichler and Raciborski: Brunnthaler, 1915, p. 83, fig. 36.

Detached individuals: lat., 19–20 μ; long. stip., 12 μ (very rare in 6 *b*, 1136 *b*). Previously recorded for Africa.

Family CHLORELLACEAE.

Genus Trochiscia Kützing.

Trochiscia aciculifera (Lagerh.) Hansg. (=*Acanthococcus aciculiferus* Lagerheim, 1883, p. 62). (Fig. 1, *A–C*.)

Diam. cell. sine spin., 20–28 μ; long. spin., 4–10 μ. (Common in 6 *b*, 7, 72, 75, and 1136 *a*.)

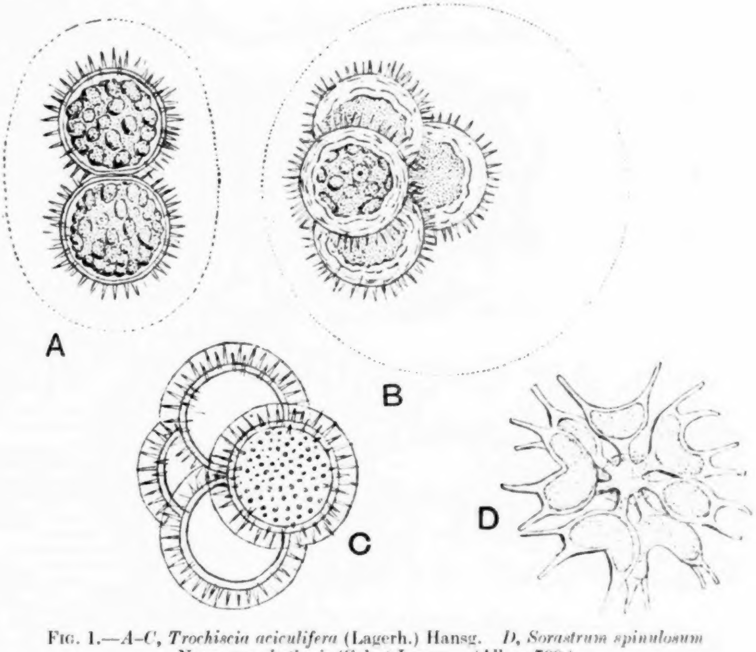

Fig. 1.—*A–C*, *Trochiscia aciculifera* (Lagerh.) Hansg. *D*, *Sorastrum spinulosum* Naeg. var. *hathoris* (Cohn) Lemm. (All × 700.)

The spherical or globose cells are found most commonly in pairs embedded in mucilage (fig. 1, *A*): they may, however, occur singly, or in colonies of four, and mucilage may not be recognisable. Each cell has a wall of irregular thickness covered with numerous fine, sharply pointed spines. Plentiful starch is present. It has not been possible to make out the nature of the chloroplast.

The available material seemed to differ in no way from the brief diagnosis of Lagerheim, but the exact status of this form remains doubtful. It has been observed in other South African samples, but was not recorded.

Genus TETRAËDRON Kützing.

Tetraëdron lobulatum (Naeg.) Hansg.; Reinsch, 1888, Pl. V, fig. 3 *a*.

Very rare in 6 *b*. A variety has previously been recorded for S. Rhodesia.

Several other species of *Tetraëdron* were present, but in too small numbers to admit of satisfactory identification.

FAMILY OOCYSTACEAE.

Genus GLAUCOCYSTIS Itzigs.

Glaucocystis nostochinearum Itzigs.; West and Fritsch, 1927, p. 493.

Parent cell, $63 \times 51\ \mu$; daughter cells, $30 \times 18\ \mu$. (72, rare.)

Genus NEPHROCYTIUM Naegeli.

Nephrocytium Agardhianum Naeg.; Rich, 1935, fig. 2, *C*.

Colonies with two or four cells measuring approximately $24\ \mu \times 13\ \mu$ (6 *b*, 1136 *a*). Previously recorded for Southern Rhodesia.

Genus OOCYSTIS Naegeli.

Oocystis elliptica West forma *minor* West, 1894, fig. 26.

Long. cell., 17 μ; lat., 8·5 μ. (Rather rare in 7, 72, 1136 *b*.) Previously recorded from Nyasa; the type from the Transvaal.

Oocystis solitaria Wittr.; Brunnthaler, 1915, fig. 94.

Cells, $15 \times 7\ \mu$; greatest width of a 4-celled colony 33 μ (72). Common in S. Africa.

FAMILY SELENASTRACEAE.

Genus ANKISTRODESMUS Corda.

Ankistrodesmus falcatus (Corda) Ralfs.

Loose bundles of numerous cells (6 *b*).

Ankistrodesmus spiralis (Turn.) Lemm. (= *Raphidium polymorphum* var. *Turneri* W. and G. S. West); Bernard, 1909, figs. 156–159 (6 *b*, 7).

Genus KIRCHNERIELLA Schmidle.

Kirchneriella lunaris (Kirchn.) Moeb. var *Dianae* Bohlin, 1897, p. 20 (7, 1136 *b*). Previously recorded for S. Africa.

FAMILY DICTYOSPHAERIACEAE.

Genus DICTYOSPHAERIUM Naegeli.

Dictyosphaerium pulchellum Wood.

Frequently recorded for S. Africa.

Family HYDRODICTYACEAE.

Genus Pediastrum Meyen.

Pediastrum Boryanum (Turp.) Menegh.

(1136 *c*, very rare.) Previously recorded for the Transvaal.

Genus Sorastrum Kützing.

Sorastrum spinulosum Naeg. var. *hathoris* (Cohn) Lemm. (Fig. 1, *D*.)

Diam. cell., 14–20 μ (6 *b*, 72). The type has been recorded from Libongo and S. Rhodesia.

Family COELASTRACEAE.

Genus Scenedesmus Meyen.

Scenedesmus bijugatus (Turp.) Kütz.

Not common (6 *b*, 7). Previously recorded from Tanganyika, Victoria Nyanza, the Transvaal, and S. Rhodesia.

Order CHAETOPHORALES.

Family CHAETOPHORACEAE.

Genus Stigeoclonium Kützing.

Stigeoclonium sp. (1136 *c*).

Family COLEOCHAETACEAE.

Genus Coleochaete de Brébisson.

Coleochaete orbicularis Pringsh.

Rather rare (7, 72). Previously recorded from Cape Province, the Transvaal, and S. Rhodesia.

Family CHAETOSPHAERIDIACEAE.

Genus Chaetosphaeridium Klebahn.

Chaetosphaeridium Pringsheimii Kleb. f. *conferta* Kleb. Cells not embedded in mucilage, 12–13 μ wide (common in 72 and 1136 *a*).

The very similar *C. globosum* (Nordst.) Kleb. has been recorded several times from S. Africa.

Order OEDOGONIALES.

Family OEDOGONIACEAE.

Genus Oedogonium Link.

Oedogonium bengalense Hirn, 1900, p. 268, Tab. XLVI, fig. 287.

Crass. cell. veget., 16–21 μ; crass. oogon., 54–64 μ, oospor., 42 μ; crass. cell. androsp., 14–15 μ. (Common in 1136 *a*, *b*.)

Vegetative cells with capitate ends, elongate basal cell; oogonia opening by a median slit, sometimes single, sometimes two or three together. Androsporangia in distinct threads.

Recorded for S. Rhodesia.

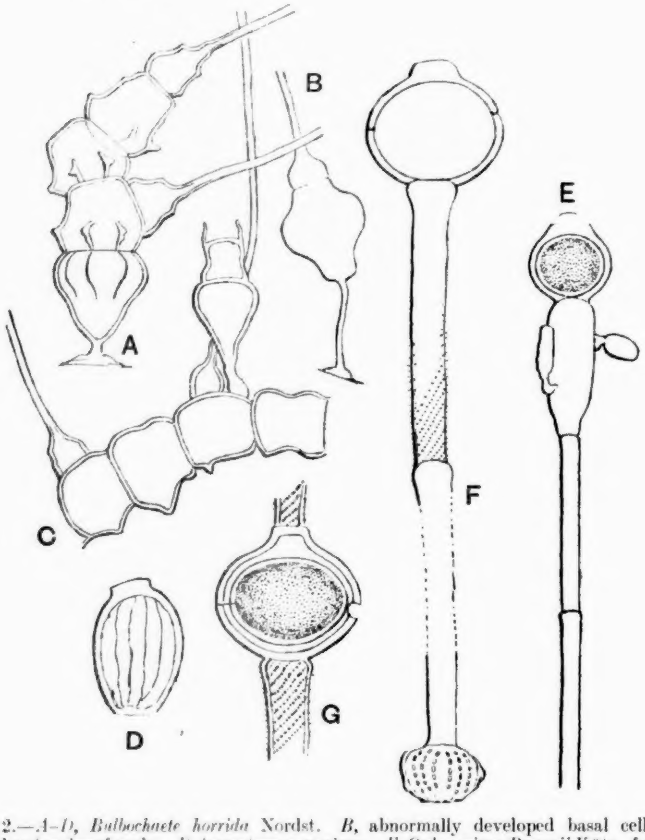

FIG. 2.—*A–D*, *Bulbochaete horrida* Nordst. *B*, abnormally developed basal cell; *C*, showing dwarf male. *D*, immature oogonium. *E*, *Oedogonium Braunii* Kütz., forma. *F–G*, *Oedogonium minus* Wittr., forma. (*A*, *B*, *F*, *G* × 750; *D*, *E* × 350.)

Oedogonium Braunii Kütz.; Hirn, 1900, p. 194, forma nov. (Fig. 2, *E*.)

This form differs from the type in the greater width of the supporting cell. It should possibly be regarded as a new variety, but the material was too scanty for this point to be satisfactorily settled.

Crass. cell. veget., 11 μ; crass. cell. suffult., 23–24 μ; crass. oogon.,

37–42 μ, oospor., 33–38 μ; crass. stip. nannandr., 8 μ, long. circa 30 μ (1136 *b*).

The type has been recorded from Griqualand West.

? *Oedogonium decipiens* Wittr.; Hirn, 1900, p. 266.

Crass. cell. veget., 9–10 μ; crass. oogon., 28–32 μ (7, 1136 *a*, *b*).

This species is very similar to *O. bengalense* but is smaller. The vegetative cells are very slightly capitate; the spore is globose and almost fills the oogonium which opens by a median slit. Oogonia single, or two or three together. No androsporangia or dwarf males were seen, hence the determination is doubtful.

? *Oedogonium minus* Wittr. forma; Hirn, 1900, p. 151. (Fig. 2, *F*, *G*.)

Crass. cell. veget., 6–9 μ; crass. oogon., 30–35 μ, oospor., 27 μ, long., 23 μ; crass. cell. antherid., 9–11 μ; crass. cell. bas., 14–19 μ, long., 13 μ (72, 75).

The spirally arranged granulations appear to mark the position of small mucilage pores. This species is closely allied to *O. punctato-striatum* De Bary, differing from it in the smaller dimensions and in being monoecious. No antheridia were observed in the sparse threads provided with oogonia, and the tentative reference to *O. minus* is based essentially on the dimensions and on the capitate ends of the vegetative cells. The dimensions are, however, slightly less than those given for the type by Hirn.

Oedogonium pusillum Kirchn.; Hirn, 1900, p. 299; Rich, 1935, fig. 5, *A*, *B*. (1136 *c*). Previously recorded from Southern Rhodesia.

Oedogonium rufescens, Wittr.; Hirn, 1900, p. 76, Tab. I, fig. 4 *b*.

Crass. cell. veget. plant. fem., 8–11 μ; crass. oogon., 19–21 μ (1134). Previously recorded from Griqualand West.

Genus Bulbochaete Agardh.

Bulbochaete horrida Nordst.; Hirn, 1900, p. 355, Tab. LIX, fig. 371. (Fig. 2, *A–D*.)

Crass. cell. veget., 12–18 μ; crass. cell. basal., 20 μ; crass. cell. basal. nannandr., 15 μ; crass. oogon., 46–60 $\mu \times$ 30–40 μ (72, 75, 1136 *a*, *b*).

There are only two previous records of this species. It was found originally by Nordstedt in the sterile condition in a collection from Brazil; subsequently Lagerheim, in a sample from Guiana, found fructifying material, and showed that the species had dwarf males, and elliptical oogonia bearing longitudinal ridges. The only figure available is that of Hirn. The longitudinal plications of the cells distinguish the species from all others. Although many filaments were present only a few dwarf males were observed, and only two collapsed oogonia. The dwarf males consist of an inflated basal cell (14–15 μ across in its widest part) and two

or three antheridial cells; they are not seated on an oogonium. The oogonia are ellipsoid with longitudinal ribs of which five or six are visible on one side. One of the basal cells observed had an unusually long stalk of attachment (Fig. 2, *B*).

Bulbochaete varians Wittr. var. *subsimplex* (Wittr.) Hirn, 1900, p. 357, Pl. LX, fig. 374.

Crass. cell. veget., 14 μ; crass. oogon., 29–32 μ, long., 34–42 μ; crass. cell. androsp., 11 μ (7, 72, 1136 *b*).

The oospores are provided with longitudinal denticulate ridges which exhibit a slight amount of anastomosis. Between the ridges a transverse striation is sometimes visible, such as is figured by Tiffany (1928, Pl. XIX, fig. 49). In this respect the oospores resemble those of *B. denticulata* Wittr., which is, however, a much larger species.

Other forms of this species have been recorded from the Transvaal and S. Rhodesia.

Order CONJUGALES.

Family MESOTAENIACEAE.

Genus Cylindrocystis Meneghini.

Cylindrocystis Brebissonii Menegh. var. *minor* W. and G. S. West.

Long. cell., 27–33 μ; lat., 11–12 μ (7, 72, very rare).

Genus Netrium Naegeli.

Netrium digitus (Ehrenb.) Itzigs. and Rothe; W. and G. S. West, 1904, p. 64, Pl. VI, figs. 14, 16.

Sides convex; dimensions 200 μ × 54 μ. (Rather common in 1136 *c*.) Previously recorded from S. Africa.

Var. *constrictum* W. and G. S. West, 1904, p. 65, Pl. VI, fig. 17.

Long., 240 μ; lat. max., 48 μ; lat. med., 45 μ (72).

The constriction was a little more pronounced than in the figure given by W. and G. S. West.

Previously recorded, from S. Rhodesia.

Netrium oblongum (De Bary) Lütkem. var. *cylindricum* W. and G. S. West, forma *curvata* Fritsch, 1918, p. 541.

Very similar in shape to the form described by Fritsch from the Cape Province, but smaller. The curvature is very slight. Long., 30–37 μ; lat., 10–12 μ (7).

Family GONATOZYGACEAE.

Genus Gonatozygon De Bary.

Gonatozygon aculeatum Hastings.

Cells only 8 μ wide. (Very rare, 1134.)

Previously recorded for the Transvaal.

Gonatozygon Brebissonii De Bary var. *minutum* W. and G. S. West.

Long., 60 μ; lat., 4 μ. (Very rare, 75.)

Cell-wall minutely granulate. The type has been previously recorded from S. Rhodesia.

Family ZYGNEMACEAE.

Genus Zygnema Agardh.

Zygnema spontaneum Nordstedt, 1878.

Diam. fil., 14–18 μ; zygospor., 20–22 μ × 24–25 μ. (Very common, 7.)

Conjugation is scalariform. The zygospore is formed in one of the conjugating cells; it is chestnut-coloured, and shows a few large scrobiculations. Previously recorded for S. Africa.

An indeterminable *Zygnema* was present in sample 7.

Genus Spirogyra Link.

Sterile *Spirogyra* occurred in Sample 1137.

Family MOUGEOTIACEAE.

Genus Mougeotia Agardh.

Mougeotia nummuloides (Hassall) De Toni.

Diam. fil., 16 μ; zygospor., 33–36 μ × 38–40 μ. (Rather rare, 7.) The spores are scrobiculate.

A single zygospore resembling that of *M. Taylori* Czurda was found in sample 75, but there was not enough material for satisfactory determination. Other species of *Mougeotia* were present, but not in a determinable condition.

Family DESMIDIACEAE.

Genus Penium De Brébisson.

Penium curtum Bréb.; W. and G. S. West, 1904, p. 97.

Long. cell., 28–30 μ; lat., 16–17 μ. (Common in 6 *b*.)

Penium variolatum W. and G. S. West, 1902, p. 135.

Smaller than the specimens described from Ceylon. Long. cell., 20 μ; lat., 7 μ (72).

Genus Closterium Nitzsch.

Closterium acutum (Lyngb.) Bréb. var. *linea* (Perty) West; Skuja, 1928, Pl. II, fig. 20.

Zygospore oblong-rectangular, ends concave, angles produced into conical prolongations; long. cum proc., 40 μ; lat. (med.), 14 μ (72).

Closterium Dianae Ehrenb.; W. and G. S. West, 1904, p. 130; forma (Fig. nostr. 3, *F*).

Dist. inter apic., 197–210 μ; lat. med., 17–20 μ; lat. apic., circa 6 μ (6 *b*, 1136 *b*).

The Wests lay special stress on the apices in describing this species, emphasising that the dorsal margin at each apex is obliquely truncate and thickened, and this feature is clearly evident in most of their figures. A

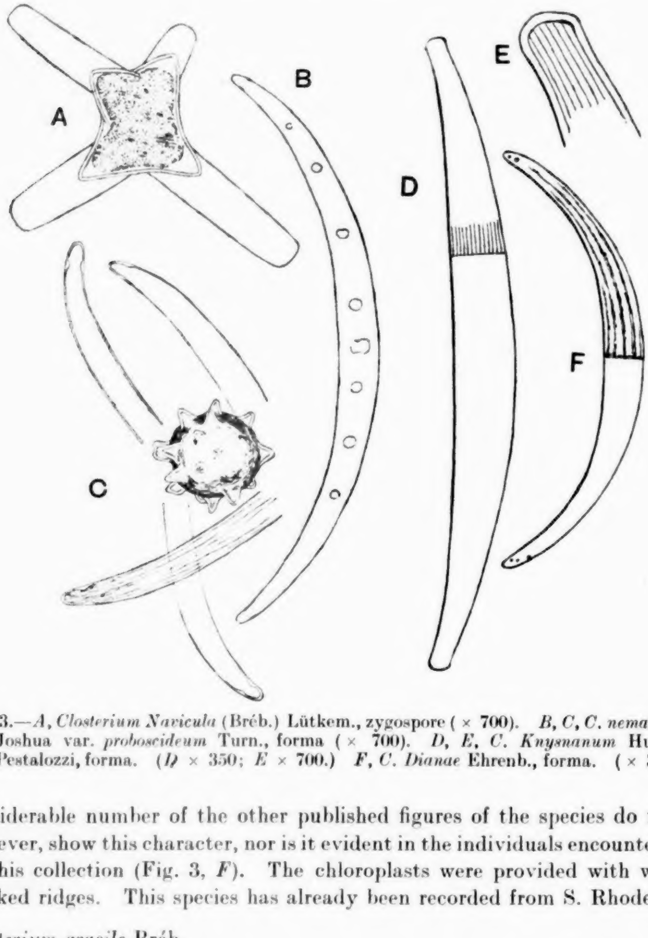

FIG. 3.—*A*, *Closterium Navicula* (Bréb.) Lütkem., zygospore (× 700). *B*, *C*, *C. nematodes* Joshua var. *proboscideum* Turn., forma (× 700). *D*, *E*, *C. Knysnanum* Huber-Pestalozzi, forma. (*D* × 350; *E* × 700.) *F*, *C. Dianae* Ehrenb., forma. (× 350.)

considerable number of the other published figures of the species do not, however, show this character, nor is it evident in the individuals encountered in this collection (Fig. 3, *F*). The chloroplasts were provided with well-marked ridges. This species has already been recorded from S. Rhodesia.

Closterium gracile Bréb.

Long. cell., 152–170 μ; lat., 4–5 μ (6 *b*). Recorded previously from the Transvaal and S. Rhodesia.

Var. *tenue* (Lemm.) W. and G. S. West.

Long. cell., 111–118 μ; lat., 3·5 μ (6 *b*).

Closterium Knysnanum Huber-Pestalozzi, 1930, p. 471, fig. 7 (8).

Forma major, apicibus non diverse coloratis. Long. cell., 270–340 μ; lat., 25–33 μ; lat. apic., 10–12 μ (6 *b*, 1136 *c*). (Fig. 3, *D*, *E*.)

The membrane is reddish-yellow in young, brown in adult individuals. There are rather prominent longitudinal striations extending the whole length of the cell, from 10 to 14 being visible across the middle. Puncta are present between the striae. This species stands rather close to *C. striolatum* Ehrenb., with which we had at first identified it. We doubt whether the different colours of the apices upon which Huber-Pestalozzi lays emphasis is a character of much importance.

Closterium Navicula (Bréb.) Lütkem. (Syn.: *Penium Navicula* Bréb.) (Fig. 3, *A*.)

Long. cell., 65 μ; lat., 14 μ; also forma *major*, long. cell., 92 μ; lat. med., 14 μ; lat. apic., 7 μ (6 *b*).

Many of the individuals had broader and more truncate apices than are shown in the figures in British Desmidiaceae (cf. Fig. 3, *A*). A few zygospores were present.

Closterium nematodes Joshua var. *proboscideum* Turner, 1892, p. 21.

Forma *minor*. Dist. inter apic., 110–125 μ; lat., 9–11 μ; diam. zygosp. sine spin., 20 μ; cum spin., 25 μ. (Common in 6 *b*.) (Fig. 3, *B*, *C*.)

There is considerable resemblance to some of the figures of var. *proboscideum* that have been published (cf. Dick, 1930, Pl. III, fig. 3), but the apical thickenings are in part indistinct and the size is considerably less than that of any hitherto recorded forms of this species or of its variety. The zygospore of the type is unknown. In the dimensions of the cell and the characters of the zygospore there is resemblance to *C. spinosporum* Hodgetts (1925, p. 72), but the latter has a smooth wall, and the apical thickenings are different.

Closterium parvulum Naeg. var. *angustum* W. and G. S. West.

Dist. inter apic., 114–130 μ; lat., 9–10 μ (6 *b*, 72, 75).

Forms described by Borge attain these dimensions, which are slightly greater than those given by W. and G. S. West.

Closterium Ralfsii Bréb. var. *hybridum* Rabenh. (6 *b*). The specimens seen much resembled the figures of Borge (1918, p. 20, Tab. II, fig. 7).

Closterium setaceum Ehrenb.

Long. cell., 312–390 μ; lat., 7–9 μ (6 *b*, 1134, rare). Recorded for Portuguese East Africa and S. Rhodesia.

Genus Docidium De Brébisson.

Docidium Baculum Bréb.

Long. cell., 180–255 μ; lat. med., 10–17 μ; lat. apic., 9–12 μ (6 *b*, 72).

Genus Pleurotaenium Naegeli.

Pleurotaenium Ehrenbergii (Bréb.) De Bary.

Long. cell., 258–330 μ; lat. bas. semicell., 18–21 μ: lat. apic., 15 μ (7, 72). Previously recorded for S. Africa.

Pleurotaenium minutum Delponte var. *elongatum* W. and G. S. West.

Long. cell., 230–248 μ; lat. ad bas. semicell., 10 μ, ad apic., 6–7 μ (72, 75).

Var. *gracile* Wille.

Long. cell., 156–178 μ: lat. ad bas. semi-cell., 11–12 μ (7).

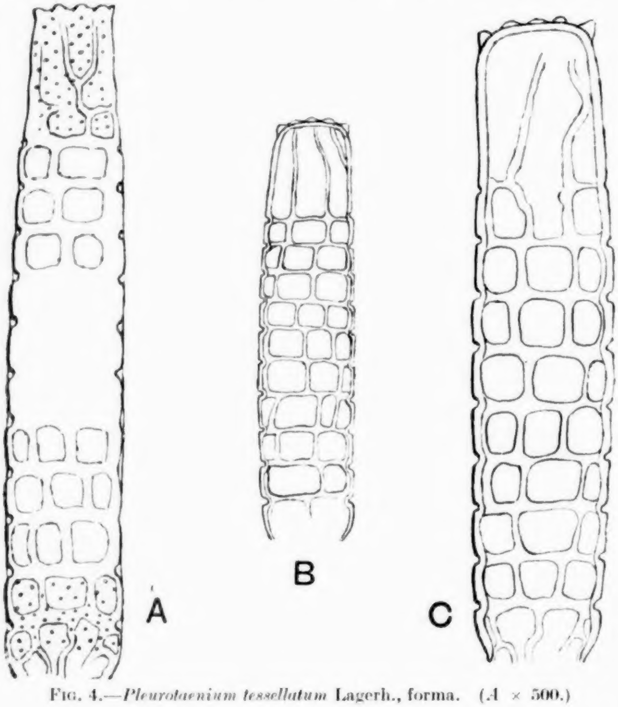

Fig. 4.—*Pleurotaenium tessellatum* Lagerh., forma. (*A* × 500.)

Pleurotaenium tessellatum Lagerh. (Syn.: *Docidium tessellatum* Joshua, 1885, p. 650).

Forma semicellulis basin versus paullo contractis, prominentibus membranae subirregulariter dispositis. Long. cell., 300–430 μ; lat. apic., 25–30 μ; lat. isthm., 29–36 μ (Fig. 4). (Rather common in 75.)

This should be compared with the form recorded by Schmidle (1899,

p. 22). There are from 9 to 11 transverse series of quadrate elevations, somewhat irregularly disposed, on each semi-cell. The surface of the membrane is punctate. There is some resemblance to var. *coronatum* Krieger (1932, p. 169, Pl. VI, fig. 12) which, however, has more of the apical tubercles.

Genus TETMEMORUS Ralfs.

Tetmemorus Brebissonii (Menegh.) Ralfs; Krieger, 1932, Pl. XXII, fig. 9.

Long. cell., 182 μ; lat. bas. semicell., 30 μ; lat. apic., 22 μ. (Very rare in 6 *b*, 1134.)

In the front view there is a very slight constriction above the isthmus and another just below the apex.

Genus EUASTRUM Ehrenberg.

Euastrum biceps sp. nov. (Fig. 5, *A–C*).

E. mediocre, plus quam duplo longius quam latius, profunde constrictum, sinu lineari introrsum leviter ampliato; semicellulae a fronte visae subtrapeziformes, incisura mediana profunda et valde ampliata, angulis inferioribus subrectangularibus plus minus rotundatis, lateribus in parte inferiore retusis, in parte superiore rectis vel leviter concavis, apicibus rotundatis, membrana cum verrucis rotundatis in lobulis apicalibus vel in parte basali semicellulae diverse dispositis; semicellulae a latere visae in parte basali rotundatae, lobo polari rectangulari, vertice recta, marginibus lateralibus verrucosis.

Long. cell., 53–60 μ; lat. med., 24 μ; isthm., 6 μ; crass., 12–16 μ. (6 *b*, 72, 75 rare.)

A characteristic feature of this species is the very deep polar incision which widens out very considerably at its lower extremity so that the whole polar sinus is roughly triangular. The two polar lobes meet together in the middle line and show a thickening of the membrane at their apices. The upper part of the lateral margin of the semicell is very slightly concave, but just above the level of the lower end of the polar sinus the margin suddenly curves inwards, the protuberances thus created often bearing two very indistinct teeth. The lower parts of the lateral margins are again divergent and slightly convex. The markings on the surface of the semicell are not very distinct, and differ on different individuals as well as on different parts of the same individual (Fig. 5, *C*). There is an irregular group of rounded nodules (some occasionally almost of the size of tumours) on the two polar lobes, and another irregular group in the basal part of the semicell, so disposed as to leave the region of the isthmus unthickened (cf. also the side-view in Fig. 5, *B*). When the semicells are slightly tilted the pair of nodules just beneath the apex of each lobe appear as a pair of

minute teeth. In side-view the lower part of each semicell appears circular, while the upper part is rectangular with sub-parallel sides and a smooth truncate apex. The lateral margins bear irregular blunt teeth (the nodules of the front-view) in two separate groups.

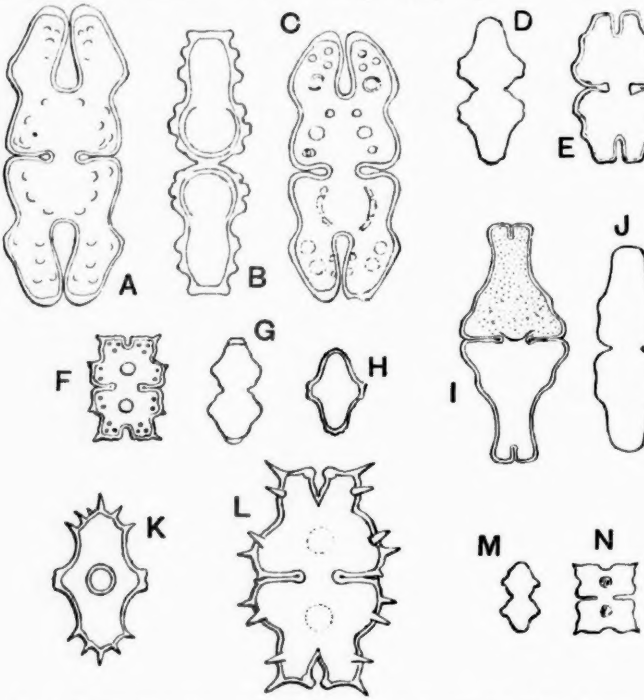

FIG. 5.—*A–C*, *Euastrum biceps* n. sp. *D*, *E*, *E. elegans* (Bréb.) Kütz., forma. *F–H*, *E. denticulatum* (Kirchn.) Gay, forma. *I*, *J*, *E. dideltoides* West, forma. *K*, *L*, *E. evolutum* West var. *integrius* West, forma. *M*, *N*, *E. rectangulare* n. sp. (*I*, *J*, × 370; the remainder × 750.)

This species bears some resemblance to *E. bilobum* Lütkemüller (1892, p. 561) and *E. fissum* W. and G. S. West (1902, p. 154), both of which have a deep polar incision, which is, however, not widened out as in *E. biceps*, nor is the shape of the semi-cells of the characteristic type found in the latter species.

Euastrum denticulatum (Kirchn.) Gray, formae (Fig. 5, *F–H*).

Long. cell., 18–22 μ; lat., 14–18 μ; isthm., 3·5–4·5 μ; crass., 9–13 μ. (6 *b*, 7, 72.)

Several different forms of this very variable species were present,

characterised by the fact that the upper part of the lateral margins were less concave than in the type; see, for instance, the form figured in Fig. 5, *F–H*. Another form resembled that described by Krieger (1932, p. 212, Pl. XX, fig. 14) from Sumatra, while others approached var. *elongatum* Nordst. (1888, Pl. III, fig. 10) although they did not attain to the dimensions of that variety.

Euastrum dideltoides W. and G. S. West, 1902, p. 147. (Fig. nostr. 5, *I, J*.)

Long. cell., 93–117 μ; lat., 41–69 μ; isthm., 12–14 μ; lat. lob. pol., 21–24 μ, crass., –33 μ. (6 *b*, 72.)

The individuals present only differed from the type as figured by W. and G. S. West in insignificant particulars. They were a trifle smaller than those described by these authors from Ceylon, those in 6 *b* being larger than those in 72. The exact arrangement of the tumours in front view could not be determined.

Euastrum elegans (Bréb.) Kütz.

Forma apice fere truncato, angulis basalibus rotundatis. Long. cell., 28–30 μ; lat., 17–20 μ; isthm., 5·5–6·7 μ. (6 *b*, 72, 75.) (Fig. 5, *D, E*.)

The form of this variable species found in the present collection is not exactly like any that has hitherto been described, though approaching var. *madagascariense* W. and G. S. West and var. *symmetricum* Fritsch and Rich. The side-view is practically identical with that of the type as figured in British Desmidiaceae (1905, Pl. XXXVIII, fig. 17 *c*). The markings on the semicells could not be clearly deciphered. Somewhat similar forms were found in the Weltevreden West Pan (Rich, 1932) and in Natal.

Euastrum evolutum W. and G. S. West var. *integrius* W. and G. S. West, 1896, p. 244.

Forma lobo polari longiore, spinis lateralibus bene evolutis. Long. cell., 48–52 μ; lat. sine spin., 28 μ; isthm., circa 7 μ (1134, 1136 *b*). (Fig. 5, *K, L*.)

Specimens of this variety have been recorded by Nygaard (1932, p. 140, fig. 38) from the Zambesi River which have a proportionally shorter polar lobe. The individuals are slightly smaller than those described by the Wests from N. America and have longer spines. The surface markings were not clearly seen. The type has been recorded from British East Africa by Schmidle.

Euastrum insulare (Wittr.) Roy; W. and G. S. West, 1905, p. 68, Pl. XL, fig. 11.

Long. cell., 22–28 μ; lat., 15–17 μ; isthm., 4 μ; crass., 10–11 μ. (Rare in 72, 75, 1136 *a*.)

A form of this species has been recorded from Old N'gamo.

Euastrum mononcylum (Nordst.) Racib. (Syn.: *E. gemmatum* Bréb. var. *mononcylum* Nordstedt, 1880, p. 8, fig. 13).

Var. *abbreviata* var. nov. (Fig. 8, *A–C*.)

Differt a typo in aspectu frontali lobo polari breviore apice truncato, lobis lateralibus superioribus fere horizontalibus, tumore centrali majore cum granulis numerosis periphericis et granulis centralis 6, spinis marginalibus bene evolutis, spinis bifidis intra marginem apicalem in utroque latere; semicellulae a vertice visae ellipticae cum tumore magno fere truncato utrobique. Long. cell., 70–80 μ; lat., 60–65 μ; lat. lob. pol., 26 μ; isthm., 14–15 μ; crass., 37–38 μ. (Rare in 75, 1134, 1136 *b* and *c*.)

The original figure of the type as published by Nordstedt (loc. cit.) shows only the front-view. The variety here described differs from other forms and varieties of *E. mononcylum* in the short, almost truncate, polar lobe, and the practically horizontal disposition of the upper lateral lobes. The median tumour is also exceptionally large and possesses a peripheral series of granules as well as six central ones; a similar arrangement has been recorded in var. *germanicum* Schmidle; cf. also var. *aequilobum* W. and G. S. West. Another special feature of the new variety is the presence of a bifid intramarginal spine within each apical angle (Fig. 8, *A*). The large size and prominence of the median tumour is also apparent in the end-view (Fig. 8, *C*). The side-view shows a characteristic broadening of the semicell towards the apex.

E. mononcylum is closely related to *E. spinulosum* Delponte (1876, p. 97, Tab. VI, fig. 17, 18), the original form of which—distinguished by the possession of numerous series of pointed spines—has apparently not been found again. Grönblad (1921, p. 16) has tabulated the essential differences between the two species.

Euastrum praemorsum (Nordst.) Schmidle (Syn.: *E. rostratum* Ralfs var. *praemorsum* Nordstedt, 1888, p. 34, Tab. III, fig. 7).

Long. cell., 63–73 μ; lat., 33–37 μ; lat. lob. pol., 22–24 μ; isthm., 8–9 μ; crass., 26–28 μ (6 *b*, 72).

Some of the individuals observed closely resembled those figured by Nordstedt (loc. cit.). Others, however, possessed a more elongate polar lobe (cf. Fig. 6, *A–C*). In all of them the notch in the lower part of the lateral margins of the semicells was well marked.

Var. *africanum* var. nov. (Fig. 6, *D–G*.)

Differt a typo semicellulis paullo brevioribus, marginibus lateralibus inferioribus solum leviter concavis, tumoribus 3 infra incisionem medianam in parte apicali; zygosporis globosis spinis acutis bene evolutis munitis. Long. cell., 60–63 μ; lat. med., 32–36 μ; lat. lob. pol., 21–24 μ; isthm., 8–10 μ; diam. zygosp. sine spin., 42 μ; long. spin., circa 10 μ (6 *b*).

This variety differs from the type in the fact that the lateral notch in

the lower part of the lateral margins is not nearly so well defined, being merely indicated by a slight concavity. The ornamentation of the surface of the semicell is also different, inasmuch as there are three tumours symmetrically disposed just beneath the apical incision. In some of the individuals seen the sinus was widely open at the outer extremity. The

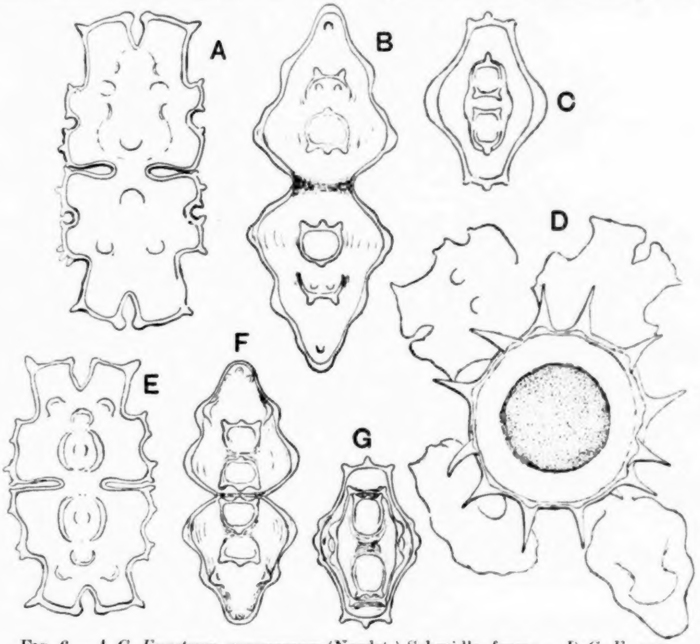

FIG. 6.—*A–C*, *Euastrum praemorsum* (Nordst.) Schmidle, forma. *D–G*, *E. praemorsum* var. *africanum* nov. var. (All × 700.)

side- and end-views resemble those of the type except in the different disposition of the tumours in the end-view (cf. Fig. 6, *G*).

Euastrum pulcherrimum W. and G. S. West, 1902, p. 153, Pl. XX, fig. 11, var. *ornatum* var. nov. (Fig. 7, *A–C*).

Differt a typo incisuris lateralibus indistinctis, spinis lateralibus vel apicalibus obtusis, tumore majore supra isthmum cum granulis 3–4 centralibus et granulis 7–9 periphericis, granulis parvis in totam superficiem semicellulae dispositis; semicellulae a latere visae trilobatae, lobo polari rotundato granulis rotundatis in marginem; semicellulae a vertice visae tumore mediano bene evoluto, polis rotundatis granulatis. Long. cell., 41–54 μ; lat., 27–33 μ; isthm., 6–8 μ; crass., 22–26 μ (6 *b*, 72).

This is a more ornate form with a less marked incision of the lateral

margins in the front-view. The disposition of the tumours on the semicells in front-view is almost exactly as in the type, but the tumour above the isthmus is larger and bears central, as well as peripheral, granules. The remaining tumours also bear a few granules, and other granules occur scattered over the whole surface of the semicell. The more ornate character, and the stronger development of the median tumour, are also

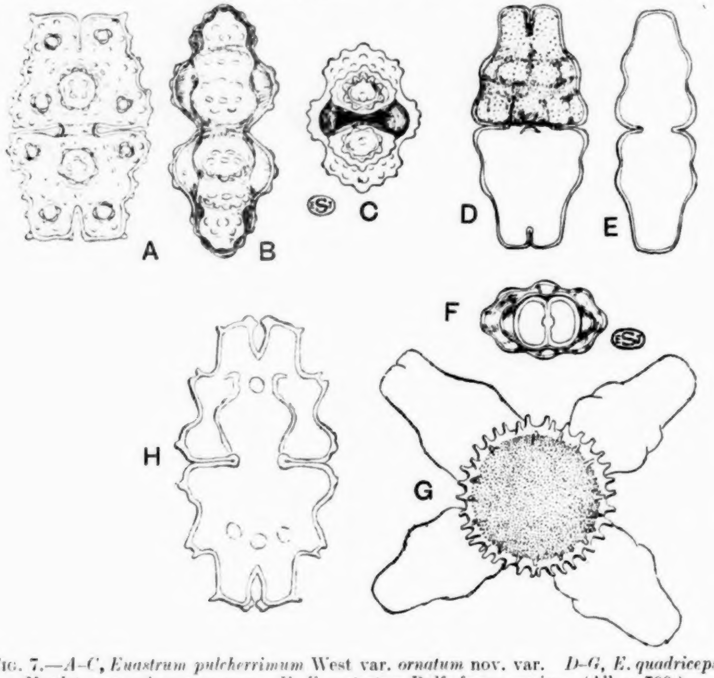

FIG. 7.—*A–C*, *Euastrum pulcherrimum* West var. *ornatum* nov. var. *D–G*, *E. quadriceps* Nordst. var. *minor* nov. var. *H*, *E. rostratum* Ralfs forma *major*. (All × 700.)

perfectly apparent in the side- and end-views (Fig. 7, *B*, *C*). In the side-view the polar lobe is markedly rounded, which rather alters the shape of the semicell as compared with the type when seen in this position. The polar incision is narrow in the middle and increases in width towards each face of the semicell (cf. Fig. 7, *C*).

Euastrum quadriceps Nordstedt, 1887, p. 216, var. *minor* var. nov. (Fig. 7, *D–G*).

Differt a typo magnitudine minore, lobo polari pro ratione latiore, marginibus lateralibus semicellulae in aspectu frontali et laterali evidenter lobulatis; aspectus verticalis quam in typo. Zygosporae globosae, luteo-

fuscae, papillis brevibus obtusis leviter curvatis numerosis munitae. Long. cell., 75–87 μ; lat., 36–41 μ; lat. lob. pol., 22–23 μ; isthm., 9–12 μ; crass., 24–29 μ; diam. zygosp. sine papill., 36 μ; long. papill., 3–4 μ. (Rare in 6 *b*, 72, 75.)

The variety differs from the type as described by Nordstedt (loc. cit.) and as subsequently recorded by G. S. West (1914, p. 1034, Pl. XXII,

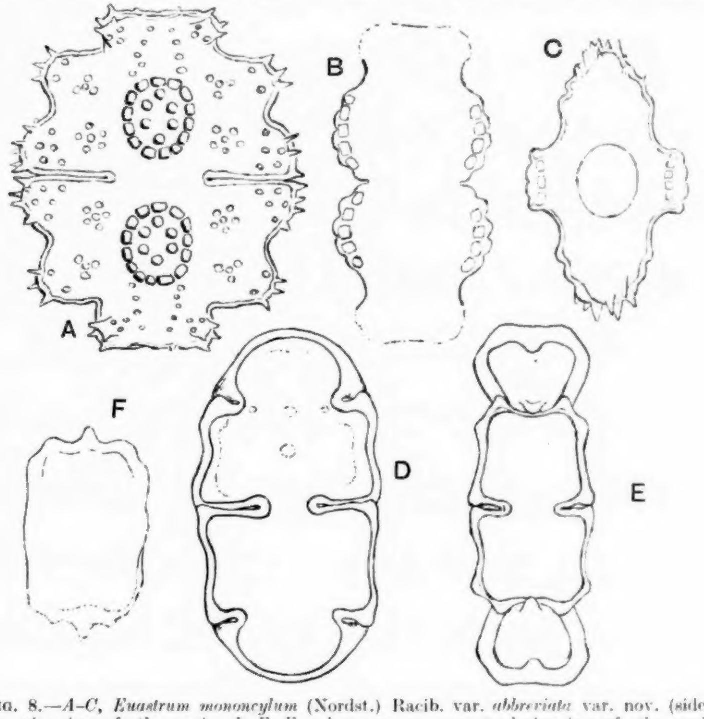

FIG. 8.—*A–C*, *Euastrum mononcylum* (Nordst.) Racib. var. *abbreviata* var. nov. (side-view imperfectly seen). *D–F*, *E. subcrassum* sp. nov. (end-view imperfectly seen). (All × 700.)

fig. 40) from Columbia, in its decidedly smaller dimensions. It is a more squat form with a relatively broader polar lobe and with the lobing of the lateral margins of the semicells more pronounced. This is also marked in the side-view, while the end-view does not differ appreciably from the type, especially as figured by West. The zygospore of *E. quadriceps* is unknown; that of the variety is spherical, yellowish brown, and densely covered with short, blunt, somewhat curved papillae. The type has hitherto been recorded only from S. America, although a form has been described by Raciborski (1892, p. 379, Pl. VII, fig. 30) from Australia.

Euastrum rectangulare sp. nov. (Fig. 5, *M*, *N*).

E. minimum, fere tam lat. quam long., profunde constrictum, sinu lineari aperto; semicellulae a fronte visae subrectangulares, angulis inferioribus rotundatis vel subrectangularibus, marginibus lateralibus in media parte concavis, angulis superioribus cum spina brevi divergenti, apice late truncato incisura mediana vadosa, membrana cum tumore parvo supra isthmum; semicellulae a latere visae ovatae apice rotundato, prominentia in latere utroque; semicellulae a vertice visae late ellipticae, tumore rotundato utrobique, polis cum spinis brevibus 3 (?). Long. cell., 10–11 μ; lat., 9–10 μ; isthm., 3–4 μ; crass., 6–7 μ (6 *b*, 7, 72, 75).

This *Euastrum* in its rectangular shape somewhat recalls *Cosmarium Regnesi* Reinsch. It has not been possible to obtain a clear view of the cell from the end, but such evidence as has been obtained indicates that there are in the end-view 3 polar spines. This would mean that, apart from the small spines at the apical angles in front-view, there is another intramarginal spine near the apical angles on each side of the semicell.

Euastrum rostratum Ralfs; W. and G. S. West, 1905, p. 35, Pl. XXXVII, fig. 12.

Long. cell., 52–56 μ; lat., 27–32 μ; isthm., 9–10 μ (6 *b*, 72, 1134, 1136 *b*).

Forma major.

Long. cell., 60–62 μ; lat., 27 μ; isthm., 8 μ (72). (Fig. 7, *H*.)

The general outline of the semicell is very similar to that usually found in *E. rostratum*, but the individuals are appreciably larger, and there also appears to be some difference in the surface markings. These were, however, never seen clearly in the few specimens that were found.

Euastrum sibiricum Boldt.

Long. cell., 16–17 μ; lat., 14–16 μ; isthm., ca. 3 μ; crass., ca. 8–9 μ (6 *b*, 75).

A variety has been described by Huber-Pestalozzi (1930) from S. Africa.

Euastrum splendens sp. nov. (Fig. 9, *A–C*).

E. mediocre, circa $1\frac{1}{5}$ plo longius quam latius, profunde constrictum, sinu valde ampliato acuto; semicellulae a fronte visae trilobatae sine incisura mediana, lobo polari valde evoluto subcylindrico apicem versus ampliato, vertice leviter convexo crenato, membrana glabra, lobis lateralibus divergentibus bilobulatis lobulis emarginatis, in superficiem partis basalis semicellularum jugis 3 symmetrice dispositis, lateralibus emarginatis mediano trilobulato; in aspectu laterali lobus polaris similis est, marginibus lateralibus partis basalis semicellulae tricrenatis, in superficiem jugis 3, lateralibus emarginatis mediano profunde bilobulato; aspectu verticali elliptico, lobis 3 rotundatis valde evolutis utrobique, lobo polari a vertice viso circulari cum granulis pluribus seriatis. Long. cell., 62–75 μ; lat., 50–51 μ; lat. lob. pol., 12–16 μ; isthm., 11–12 μ; crass. (max.), 32–43 μ (72).

This striking form shows a tendency to radial symmetry and therefore an approach to the genus *Euastridium* (W. and G. S. West, 1907, p. 199, Pl. XIV, fig. 11). The end-view (Fig. 9, *C*) is elliptic in general outline, but shows on each side three prominent rounded lobes, which in the front-view (Fig. 9, *A*) appear as three ridges on the basal part of the semicell.

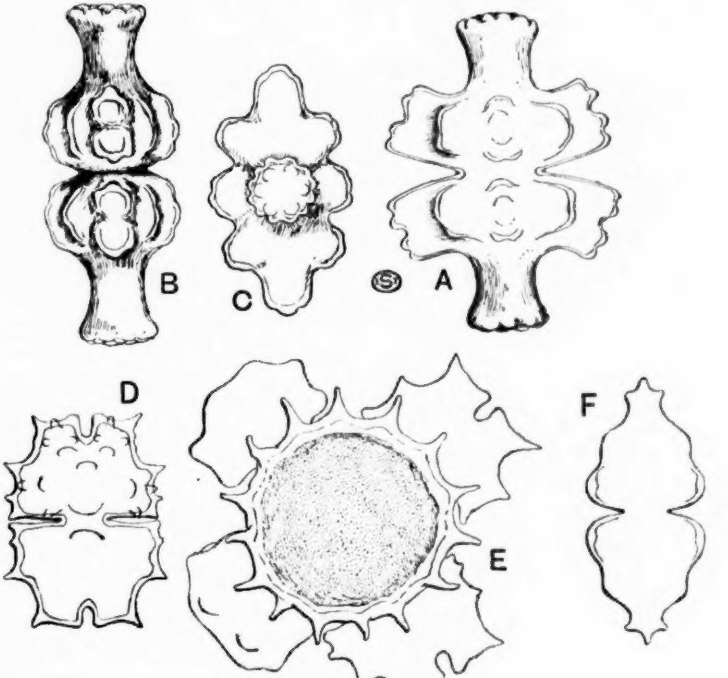

Fig. 9.—*A–C*, *Euastrum splendens* sp. nov. *D–F*, *E. subpraemorsum* sp. nov. (All × 750.)

The median ridge is tricrenate (cf. Fig. 9, *B*), while the lateral ones are emarginate. The conspicuous polar lobe is without an apical incision and widens towards the apex, which appears crenate (Fig. 9, *A*, *B*). In the end-view the polar lobe is seen to be cylindrical, and the crenate appearance of its apex to be due to several series of marginal and intramarginal granules. Elsewhere the membrane is smooth.

The new species shows resemblances to *E. attenuatum* Wolle as described and figured by W. and G. S. West (1896), as well as with *E. pectinatum*,

Bréb. var. *porrectum* Borge (1901), which G. S. West (1914, p. 1032) identifies with the former. As compared with *E. attenuatum* the new species is broader, has a widely open isthmus, a somewhat different polar lobe, and a more elaborate development of the rounded ridges on the basal part of the semicell. Borge's form agrees with *E. splendens* in dimensions and in the widely open isthmus, but, judging by the front-view of which details alone are available, it would seem to be less complex and with rather shorter lateral lobes. We do not agree with the reference of this form to *E. attenuatum* Wolle, since it shows manifest differences; it should be regarded either as a variety of *E. attenuatum*, or perhaps, better, as a variety of *E. splendens*.

Euastrum subcrassum sp. nov. (Fig. 8, *D–F*).

E. submagnum, ca. duplo longius quam latius, elliptico-oblongum, profunde constrictum, sinu angusto lineari interdum subaperto, membrana crassa minute scrobiculata; semicellulae a fronte visae trilobatae, incisura inter lobum polarem et lobos laterales angusta vel subaperta, lobo polari late cuneato sine incisura mediana apice distincte convexo, marginibus lateralibus leviter concavis, angulis basalibus rotundatis; semicellulae a latere visae subrectangulares, lobo polari apice truncato dente obtuso in parte basali, lobis lateralibus leviter cuneatis; semicellulae a vertice non satis visae, quadratae (?).

Long. cell., 75–86 μ; lat., 40–44 μ; isthm., 7·5–9 μ; crass. (max.), 24–30 μ (6 *b*, 7, 72).

This *Euastrum* is characterised by its thick minutely scrobiculate membrane, its entire polar lobe appearing as a convex hump in the front-view, and by the side-view (Fig. 8, *E*). In general outline there is resemblance to *E. crassum* (Bréb.) Kütz., a much larger form with a smaller polar lobe showing the usual median incision. Other somewhat similar species are *E. truncatum* Joshua (1885) and *E. capitatum* Huber-Pestalozzi (1930, p. 462, fig. 72). In the former the apex of the polar lobe is concave, while in both there is no appreciable thickening of the membrane, and the side-view is altogether different. Forms like *E. subcrassum* in their entire polar lobe form a link between *Micrasterias* and *Euastrum* (cf. Huber-Pestalozzi, 1930, p. 463) and in this connection attention may specially be directed to *Micrasterias suboblonga* Nordstedt (1888).

Euastrum subhypochondrum, sp. nov. (Fig. 10).

E. submagnum, tam longum quam latum, profundissime constrictum, sinu acuto valde ampliato dente obtuso in media parte; semicellulae a fronte visae trilobatae sine incisura mediana, lobo polari brevi cylindrico apice truncato angulis apicalibus cum spinis pluribus, lobis lateralibus plus minus divergentibus margine superiore fere recta margine inferiore leviter

convexa angulis externis rotundatis cum spinis pluribus, in superficiem semicellulae tumore centrali magno cum granulis in series tres (10–12 : 5–6 : 1), tumore laterali obscuro utrobique cum granulis 3–5, et

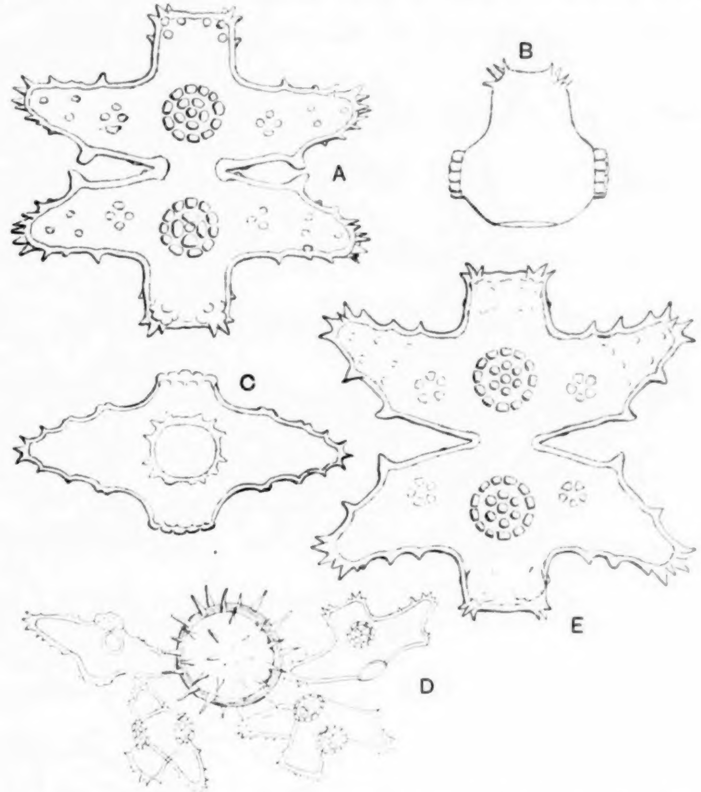

FIG. 10.—*A–E*, *Euastrum subhypochondrum* sp. nov. (*A*, *B*, *C*, *E*, × 600; *D* less highly magnified.) *D* from drawing by Dr. Doidge.

granulis aliis sparsis; semicellulae a latere visae trilobatae, angulis apicalibus spinosis, marginibus lateralibus in parte basali cum tumore magno; semicellulae a vertice visae ellipticae polis spinosis tumore magno utrobique, lobo polari subrectangulari; zygosporae globosae spinis acutis basin versus dilatatis munitae. Long. cell., 83–97 μ; lat., 83–97 μ; lat. lob. pol., 21–25 μ; isthm., 14–16 μ; crass., 41–42 μ; zygospor. sine spin., circa 60 μ. (6 *b*, 7, 75, 1136 *b*.)

This species, as the name suggests, stands nearest to *E. hypochondrum*

Nordst., especially in the character of the end- and side-views. *E. subhypochondrum* is, however, considerably larger, and the front-view is rather different. The upper margin of the lateral lobes is almost a straight line (Fig. 10, *A*), while the lower margin is more or less convex. The sinus is thus widely open, although a projecting tooth situated at about the middle of the lower margin of each lateral lobe may almost meet its vis-à-vis. There may also be a second tooth near the isthmus. The median tumour is more strongly developed than in *E. hypochondrum* (evident also in side- and end-views, Fig. 10, *B*, *C*) and bears a central granule apart from the two peripheral series. The single granule just above the isthmus is lacking, but on either side of the central tumour are faint 3–5-granulate tumours; the remaining granules show no very definite arrangement. The spines at the angles of the semicells are better developed than in *E. hypochondrum*. Other species with which *E. subhypochondrum* can be compared are *E. bellum* Nordst., *E. Hieronymusii* Schmidle, and *E. stellatum* Nordst.

The zygospore was not found by us, but we reproduce a drawing of it sent us by Dr. Doidge many years ago.

Euastrum subpraemorsum sp. nov. (Fig. 9, *D–F*).

E. mediocre, ca. $1\frac{1}{2}$ plo longiore quam latiore, profunde constrictum, sinu anguste lineari; semicellulae a fronte visae subquadratae, incisura mediana subprofunda aperta, angulis basalibus subquadratis, marginibus lateralibus in parte inferiore lobulo emarginato, in parte mediana spina acuta praeditis, in parte superiore concavis, angulis superioribus cum spina acuta, lobo polari paullo evoluto, apice fere recto, spinis brevibus 3 intra marginem in utroque latere lobi polaris et spina brevi 1 intra marginem lateralem semicellulae unamquamque, tumoribus rotundatis pluribus in superficiem semicellulae, unum supra isthmum; semicellulae a latere visae pyramidatae, trilobatae, apicibus trifidis; semicellulae a vertice non visae. Zygosporae globosae, spinis obtusis circa 8 μ longis munitae. Long. cell., 44–50 μ; lat., 27–32 μ; isthm., 9 μ; crass., 23–26 μ; diam. zygosp. sine spine, circa 40 μ (1134, 1136 *c*).

We have had considerable difficulty in determining the status of this *Euastrum*, which shows some characteristics of *E. praemorsum* (Nordst.) Schmidle, but differs from it altogether in the poor development of the polar lobe, as well as in relative dimensions; the intramarginal spines are, moreover, peculiar, and the disposition of the rounded tumours different. The appearance of the side-view is very characteristic, the trifid apices being due to the apical (marginal) spine and the adjacent intramarginal spine on either side. As far as the front-view is concerned there is some resemblance in general outline to a form of *E. rostratum* figured by Borge (1903, Tab. IV, fig. 28).

Genus Micrasterias Agardh.

Micrasterias apiculata (Ehrenb.) Menegh., forma Borge, 1918, p. 68, Tab. V, fig. 34.

Long. cell., 330 μ; lat., 255 μ (very rare in 72).

Micrasterias crux-melitensis (Ehrenb.) Hass. var. *aequalis* Rich, 1932, p. 168, fig. 6, *A*.

Long. (max.), 129 μ; lat., 126 μ; isthm., circa 14 μ (rare in 72).

The cell-wall is delicately punctate. This variety, already recorded from the Transvaal, shows some resemblance to *M. radiata* Hass., but it is more robust, and the median lobe is less extended.

Micrasterias decemdentata (Naeg.) Arch.; Naegeli, 1849, Tab. VI, *H*, fig. 2.

Forma lobis lateralibus minus dissectis. Long. cell., 40–44 μ; lat. cum spin., 52–57 μ; isthm., 10–11 μ (72, 1136 *a*). (Fig. 11, *B, C*.)

The polar lobe in these specimens is almost exactly like that of the type as figured by Naegeli (loc. cit.), the apex being rather faintly convex and the spines at the apical angles being directed upwards. Most of the subsequently published figures of *M. decemdentata* show a much more markedly convex polar lobe, and horizontally directed spines. In Naegeli's figures the lateral lobes are more deeply dissected than in our specimens, in some of which, in fact, the lateral lobes were merely bidentate with a broad concavity between them (Fig. 11, *C*).

Micrasterias radiata Hass.; W. and G. S. West, 1905, p. 113, Pl. LII, fig. 2. (Fig. nostr. 11, *D*.)

Long. cell. cum proc., 165–182 μ; lat., 156–180 μ; isthm., 18–24 μ; lat. lob. pol., 20 μ; crass., 35 μ (72, 75, 1134, 1136 *b*).

The incision between the polar and lateral lobes is much deeper than that between the two divisions of the lateral lobes, as in the figure of West cited. The teeth at the ends of the processes of the polar lobe are long and curved, those of each pair in opposite directions. The end-view (Fig. 11, *D*) shows a more marked median inflation than the figure in British Desmidiaceae. This species has been recorded from Central Africa by West.

Micrasterias tropica Nordstedt, 1887, p. 219, Tab. II, fig. 15 *b* (Syn.: *M. expansa* Bailey var. γ, Wallich, 1860, p. 5, Tab. XIII, fig. 9).

Var. *tenuior* var. nov. (Fig. 11, *A*).

Differt a typo lobis lateralibus leviter divergentibus tenuioribus marginibus superioribus et inferioribus fere rectis, processibus lobi polaris longioribus. Long. cell. cum proc. apic., 138–146 μ; long. cell. sine proc., 81–100 μ; lat., 130–160 μ; isthm., 13–16 μ (72, 75).

This variety differs from the type as described by Wallich and Nordstedt in the apical processes being longer, in the lateral processes being longer,

thinner, and upwardly divergent, and in their having practically straight margins. All this results in a form giving a more slender impression than any that has hitherto been described, apart from the f. *gracilior* of Schmidle

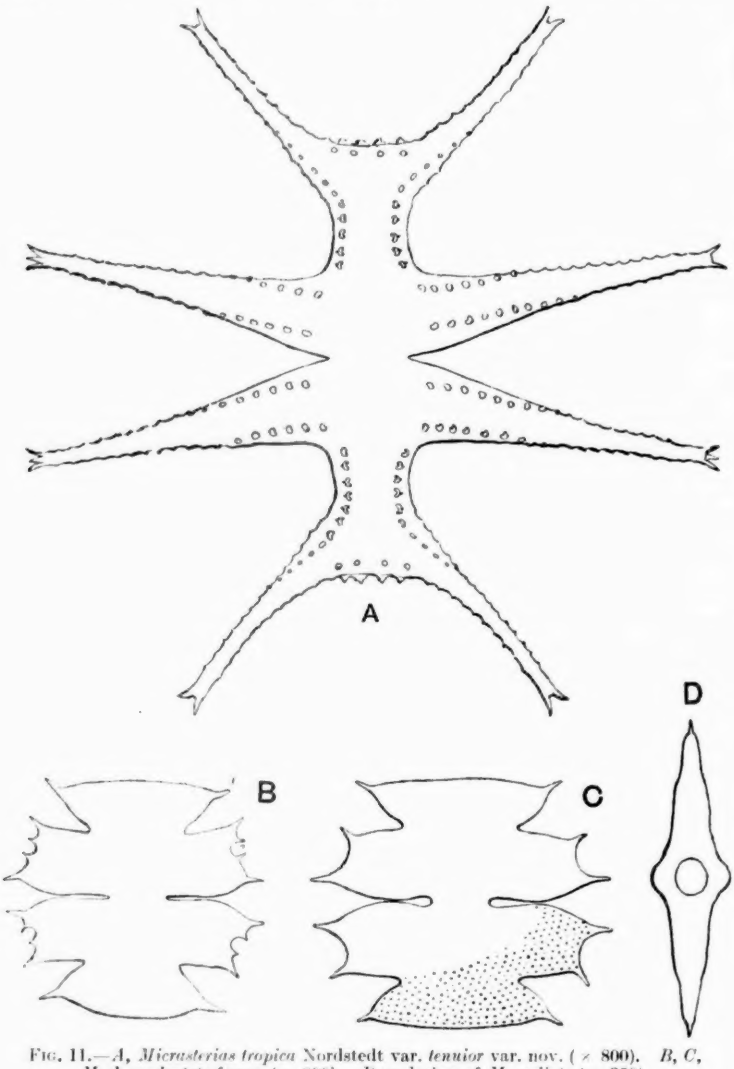

FIG. 11.—*A*, *Micrasterias tropica* Nordstedt var. *tenuior* var. nov. (× 800). *B*, *C*, *M. decemdentata* forma (× 800). *D*, end-view of *M. radiata* (× 350).

(1899, p. 48, Tab. III, fig. 12) which differs in several other respects. The apex in our specimens is furnished with a crown of eight small spines with an inflated base, and the intramarginal granules on the rest of the semi-cell seem to have a somewhat similar shape, although the spine is very minute. The degree of divergence of the lateral processes varies; sometimes they are almost horizontal, sometimes they diverge more than in Fig. 11, *A*.

A form and two varieties of this species were described by the Wests from Welwitsch's collection, and another form was recorded from the Weltevreden West Pan.

Genus COSMARIUM Corda.

Cosmarium abbreviatum Racib.; W. and G. S. West, 1908, p. 84, Pl. LXXII, fig. 11.

Long. cell., 21 μ; lat., 18–22 μ; isthm., 5 μ; crass., 10 μ; diam. zygosp., 21 μ (7).

Only one immature zygospore was observed; this was spherical and possessed a smooth membrane. The zygospore of this species has not previously been described.

Var. *planctonicum* W. and G. S. West, 1908, p. 85, Pl. LXXII, fig. 13.

Long. cell., 20 μ; isthm., 4 μ (7).

The superior angles are more rounded than in the type.

Cosmarium adoxum W. and G. S. West.

Forma papillis minoribus.

Long. cell., 9·5–10·5 μ; lat., 9·5–10 μ; isthm., 2·5 μ (6 *b*, 75).

Cosmarium asymmetricum Rich, 1935, p. 132, fig. 10, *D–G*.

Long. cell., 18 μ; lat., 16 μ (rare in 6 *b*).

Previously recorded from Old N'gamo (S. Rhodesia).

Cosmarium bireme Nordst.; W. and G. S. West, 1908, p. 77, Pl. LXXI, fig. 37.

Long. cell., 12 μ; lat., 10 μ; isthm., 2·5 μ (6 *b*).

Previously recorded for the Transvaal.

Forma marginibus lateralibus inferioribus divergentibus, iis superioribus convergentibus, latitudine maxima semicellulae in media parte. Long. cell., 14–16 μ; lat., 14 μ; isthm., 3·5–4·5 μ (6 *b*). Cf. var. *crassum* forma G. S. West (1912, p. 85, fig. 39).

The lower parts of the sides diverge, the upper parts converge to about the same degree, the greatest width of the semicell being at the middle. The end- and side-views show the papillae characteristic of the type. The dimensions are a little greater than those given by the Wests for the type.

Cosmarium bituberculatum sp. nov. (Fig. 12, *E, F*).

C. submediocre, paullo longius quam latum, profunde constrictum, sinu late aperto; semicellulae a fronte visae late subhexagonis, angulis basalibus

obtusis rotundatis, marginibus lateralibus inferioribus divergentibus, superioribus apicem versus convergentibus et in apicem transientibus, apicibus leviter convexis, infra apicem papillis contiguis 2 magnis, in superficiem cum scrobiculis parvis hexagonaliter dispositis; semicellulae a latere

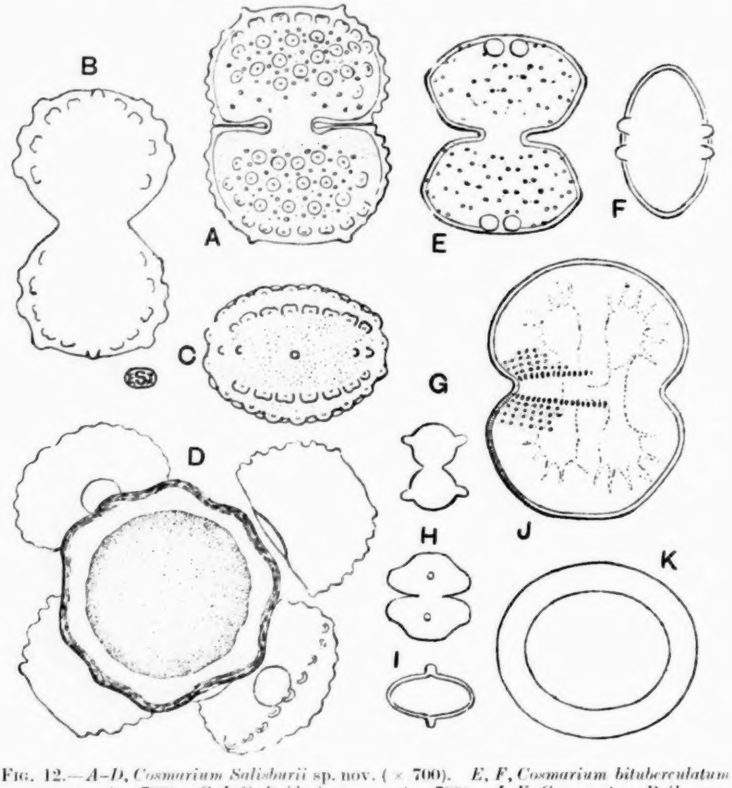

FIG. 12.—*A–D, Cosmarium Salisburii* sp. nov. (× 700). *E, F, Cosmarium bituberculatum* sp. nov. (× 700). *G–I, C. Doidgei* sp. nov. (× 700). *J, K, C. connatum* Bréb. var. *africanum* var. nov. (× 450).

non distincte visae, subcirculares; semicellulae a vertice visae ellipticae, polis rotundatis, papillis rotundatis 2 intra marginem in utroque latere.

Long. cell., 43–50 μ; lat., 35–41 μ; isthm., 10–14 μ; crass., 20–22 μ (6 *b*, 7, 75, 1136 *a–c*).

This species is characterised by the shape of its semicells in the front-view (Fig. 12 *E*) and by the two large median papillae situated just beneath the apex. It shows considerable resemblance to *C. pseudo-sulcatum* Rich

(1935) in which, however, the cell is proportionally longer, the semicells are of a different shape, and there is a characteristic thickening of the membrane in the neighbourhood of the isthmus. There is some similarity to *C. sulcatum* Nordst., but, unlike that species, the broadest part of the semicell is distinctly above the middle, and characteristic apical papillae are present. Similar papillae are found in *C. mamilliferum* Nordst., of which Messrs. West have described a var. *madagascariense*, but here the isthmus is closed and the shape of the semicell in front-view different, while the dimensions are less; the end-view is, however, practically identical with that of the new species. It is of interest to note that all the *Cosmaria* possessing two infra-apical papillae are confined to the southern hemisphere or occur in regions near it.

Cosmarium Blytii Wille; W. and G. S. West, 1908, p. 225, Pl. LXXXVI, figs. 2–4.

Long. cell., 12–16 μ; lat., 13–15 μ; isthm., 4 μ (6 *b*, 7, 72).

Apex truncate, or with 4 faint undulations; upper part of sides retuse, the lower and longer part convex with three crenations. The side- and end-views show a median papilla. Previously recorded for S. Africa.

Cosmarium connatum Bréb.

Forma cellulis a fronte visis constrictione vadosa, forma Krieger, 1932, Tab. VIII, figs. 14, 15, proxime accessit.

Long. cell., 90–94 μ; lat., 70 μ; isthm., 68 μ (7, 72). (Fig. 13, *E*.)

The cells are very slightly constricted, and have a faintly flattened apex. The cell-wall is finely scrobiculate, and densely but minutely punctate between the scrobiculations. There is some resemblance to *C. alpestre* Roy et Biss., which differs in the proportion of length to breadth, and in the markings on the cell-wall.

Var. ***africanum*** var. nov. (Fig. 12, *J*, *K*).

Differt a typo constrictione plus profunda, semicellulis hemisphericis, latitudine maxima prope partem basalem, serie granulorum majorum supra isthmum utrobique. Long. cell., 84–98 μ; lat., 63–74 μ; isthm., 47–53 μ (6 *b*, 7, 72, 1136 *a*).

This variety differs in the rather deeper constriction (which resembles that of var. *truncatum* West), in the shape of the semicells, and in the row of large granules (tubercles) above the isthmus in each semicell. It is somewhat similar to a form described by Borge (1903, p. 93) from Brazil.

The type recorded from Old N'gamo.

Cosmarium contractum Kirchn.; W. and G. S. West, 1905, p. 170, Pl. LXI, figs. 23–25.

Several forms of this species were present, all possessing a finely punctate membrane and a narrow isthmus.

Forma 1. Semicells elliptical, often not far from circular, completely rounded, with or without a wide open sinus. Dorsal and ventral margins equally rounded.

Long. cell., 36 μ; lat., 24–25 μ; isthm., 5–6 μ (6 *b*).

Forma 2. Semicells elliptical; the apex tending to be flat and slightly thickened; the sinus is more widely open; cf. forma *Jacobsenii* (Roy.) W. and G. S. West.

Long. cell., 37–39 μ; lat., 24–25 μ; isthm., 6 μ (6 *b*).

Var. *ellipsoideum* (Elfv.) W. and G. S. West, 1905, p. 172, Pl. LXI, figs. 28, 35.

Long. cell., 25–28 μ; lat., 20–24 μ; isthm., 4·5–6 μ; diam. zygosp., 22–25 μ (6 *b*, 7, 72).

The length and breadth more nearly equal; zygospore globose and smooth; dimensions a little less than those given by Messrs. West.

Cosmarium Cucurbita Bréb.; W. and G. S. West, 1908, p. 106, Pl. LXXIII, figs. 31–33. (Fig. nostr. 13, *I*.)

Long. cell., 27–30 μ; lat., 16–17 μ; lat. zygosp. sine sp., 24–26, cum sp., 37 μ.

The wall is rather coarsely punctate, the puncta are strictly aligned near the isthmus, and the part of the semicell immediately above the isthmus is free of them. Numerous zygospores were observed. These were spherical, and provided with large tubercles. Homfeld (1929, p. 41, Tab. V, fig. 54) has recorded smooth zygospores for this species, but his figure is scarcely convincing; they may not belong to this species, nor is it certain that they are mature. Grönblad (1921, p. 43, Pl. VII, fig. 63) figures a verrucose zygospore which is also possibly not quite mature. Messrs. West record the zygospores as verrucose, although they had previously described them as smooth. Either the tubercles develop at a late stage, or there happen to be two very similar species, the one with smooth, the other with verrucose zygospores.

Var. *attenuatum* G. S. West; W. and G. S. West, 1908, p. 108, Pl. LXXIII, fig. 34 (Syn.: *C. conicum* W. and G. S. West).

Long. cell., 27 μ; lat., 16 μ (6 *b*, 7, 72, 1136 *b*).

The type has been recorded from Madagascar, and the variety from thence and from Natal.

Cosmarium cucurbitinum (Bisset) Lütkem. *forma*, W. and G. S. West, 1904, p. 96, Pl. IX, fig. 15.

Long. cell., 66 μ; lat., 26–27 μ (6 *b*).

Cosmarium decoratum W. and G. S. West, 1895, p. 61, Pl. VII, fig. 21.

Long. cell., 79–90 μ; lat., 58–65 μ; isthm., 22–30 μ; crass., 36–40 μ (6 *b*, 72, 75).

The individuals noticed were just like those described by Messrs. West from Madagascar except that the markings on the surface did not always appear to be triangular: frequently they were more or less obovate.

Cosmarium diplosporum (Lund.) Lütkem. (Syn.: *Cylindrocystis diplospora* Lund.; W. and G. S. West, 1904, p. 61).

Long., 62 μ; lat., 34 μ (1136 *a*, *c*).

The curious double zygospores characteristic of this species were present. The spores were flattened on the faces adjoining one another, and measured about 39 μ by 30 μ. Schmidle (1899, p. 16) found a variety *stenocarpa* in East Africa, but that differs from the individuals here recorded in having quadrate zygospores.

Var. *majus* West; W. and G. S. West, 1904, p. 61, Pl. IV, fig. 43.

Long. cell., 83–90 μ; lat., 42–44 μ; isthm., 39–41 μ (7).

The dimensions are less than those given by Messrs. West, but there is close agreement in other respects.

Cosmarium docidioides Lütkem. (Syn.: *Penium minutum* (Ralfs), Cleve) var. *crassum* West; W. and G. S. West, 1904, p. 105, Pl. X, fig. 11.

Long. cell., 85 μ; lat., 16 μ (75).

Cosmarium Doidgei sp. nov. (Fig. 12, *G–I*).

C. parvum, ca. tam longum quam latum, profunde constrictum, sinu angusto-lineari extrorsum ampliato; semicellulae a fronte visae late subpyramidatae, angulis lateralibus rotundatis, marginibus lateralibus superioribus retusis, apice recto angusto, papillo singulo supra isthmum, membrana glabra; semicellulae a latere visae pyriformes, apice convexo, papillo singulo bene evoluto infra apicem in utroque latere; semicellulae a vertice visae ellipticae, papillo rotundato in utroque latere.

Long. cell., 18–20 μ; lat., 19–21 μ; isthm., 4–5 μ; crass., 11 μ (1134, 1136 *a*).

The retuse character of the upper lateral margins, combined with the widening of the sinus towards the outside, gives the lateral angles of the semicells the appearance of being slightly upturned. The papilla in the median part of each semicell is well developed, and directed towards the apex (cf. Fig. 12, *G*). Side- and end-views of this species rather recall *C. bireme* Nordst., but the front-view is altogether different. There is also resemblance to *C. Sinostegos* Schaarschm.

Cosmarium elegantissimum Lund. var. *simplicius* W. and G. S. West.

Forma major. Long. cell., 50–73 μ; lat., 20–32 μ; isthm., 17–26 μ (6 *b*, 7, 72, 1134). (Fig. 13, *D*.)

The form present in the Belfast Pan is larger than var. *simplicius*, although it shows the same relative proportions. The side-view is only a little narrower than the front-view. The semicells commonly broaden

slightly from the base upwards, being broadest near the top. Each semi-cell bears 8 or 9 horizontal rows of warts, 19 or 20 of which are visible round the margin. When viewed from the surface these warts appear

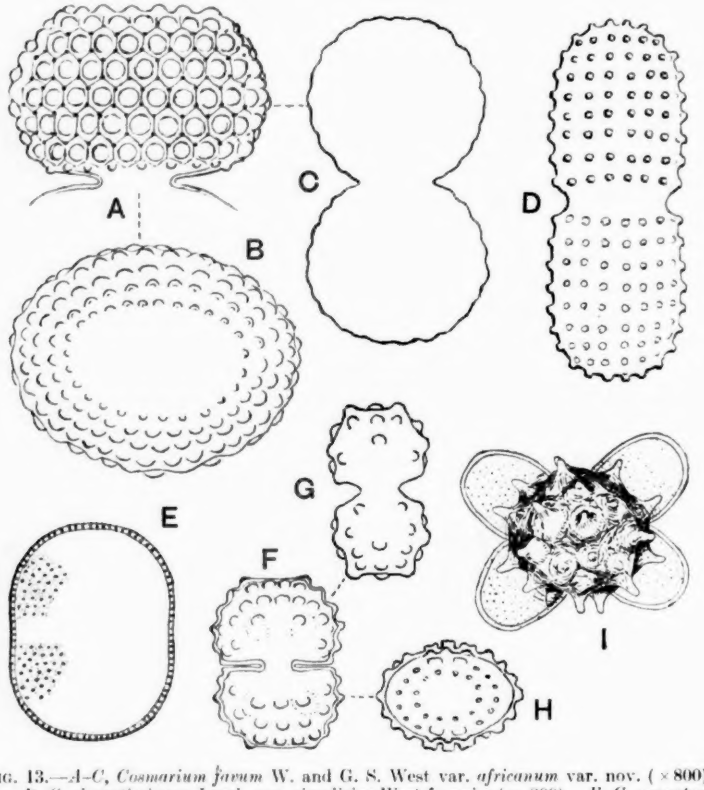

FIG. 13.—*A–C*, *Cosmarium favum* W. and G. S. West var. *africanum* var. nov. (× 800). *D*, *C. elegantissimum* Lund. var. *simplicius* West f. *major* (× 800). *E*, *C. connatum* Bréb., forma (× 370). *F–H*, *C. transvaalense* sp. nov. (× 800). *I*, *C. cucurbita* Bréb. (× 700).

circular, or somewhat oblong, but seen in optical section along the margin they are somewhat flattened at the apex.

C. elegantissimum bears considerable resemblance to *C. mansangense* W. and G. S. West, and the latter species should possibly be regarded but as a variety of the former. *C. mansangense* has been recorded from Weltevreden West and Portuguese East Africa, and a variety from Natal.

Cosmarium favum W. and G. S. West, 1896, p. 250, Pl. XV, figs. 5 and 6.
Var. *africanum* nov. var. (Fig. 13, *A–C*).

Differt a typo sinu aperto extremo acuto, semicellulis cum apice deplanato, granulis fere totam membranam obtectis. Long. cell., 64–67 μ; lat., 52–53 μ; isthm., 16 μ; crass., 34–37 μ (6 *b*, 7, 1136 *a* and *b*).

This is clearly a variety of this characteristic species, distinguished by the flattened apices of the semi-cells, a different isthmus, and the small size of the unornamented area above the isthmus. There are two pyrenoids in each semicell. The thick membrane is covered with large rounded granules surrounded by hexagonal areas with puncta at the angles. The granules, as seen in front-view, are arranged in about six horizontal and about twelve vertical rows: the granules of the row just above the isthmus are slightly smaller than the others.

Schmidle (1898, p. 36) considered *C. favum* to be a variety of *C. margaritatum* (Lund.) Roy and Biss., but Messrs West (1900, p. 294) have given good reasons for retaining it as a separate species.

It has not been previously recorded from Africa.

Cosmarium Hammeri Reinsch. var. *africanum* Fritsch.

Forma marginibus lateralibus inferioribus late rotundatis vel saepe subrectis et leviter divergentibus.

Long. cell., 22–26 μ; lat., 17–21 μ; isthm., 4–6 μ; lat. apic., 11 μ; crass., 12–13 μ; diam. zygosp. sine spin., 24 μ (6 *b*, 7, 72). (Fig. 14, *C–H*.)

There is considerable variation in the shape and degree of divergence of the lower parts of the lateral margins which are sometimes almost subparallel (cf. Fig. 14, *C*, *E*). The apex is truncate, sometimes very slightly convex; not uncommonly the apices of the two semicells are not parallel to one another. All the angles are generally rounded. The end-view has a median protuberance. In all instances the cell-wall is granulate. In some individuals the lower lateral margins were slightly sinuous, in this respect approaching var. *sinuatum* Borge (Fig. 14, *H*).

The variety has been recorded from Cape Colony.

The zygospore of the type is unknown, but that of var. *protuberans* W. and G. S. West is described as globose and furnished with numerous simple spines which are dilated at the base (W. and G. S. West, 1905, p. 183). A similar description would apply to the zygospore of the form under discussion, but the bases of the spines are much more distinctly swollen than in var. *protuberans*.

Cosmarium laeve Rabenh.; W. and G. S. West, 1908, p. 99, Pl. LXXIII, fig. 13.

Long. cell., 21–22 μ; lat., 13–14 μ; isthm., 4 μ. (Rather rare in 72.)
Previously recorded for S. Africa.

Cosmarium lobatum Boergesen, 1890, p. 42.

Var. *elliptica* var. nov. (Fig. 14, *L–N*).

Differt a typo semicellulis in aspectu verticali late ellipticis polis rotundatis, membrana scrobiculata. Long. cell., 44–64 μ; lat., 36–48 μ; isthm., 17–19 μ; crass., circa 31–36 μ. (Rare in 1134, 1136 *a*, *c*.)

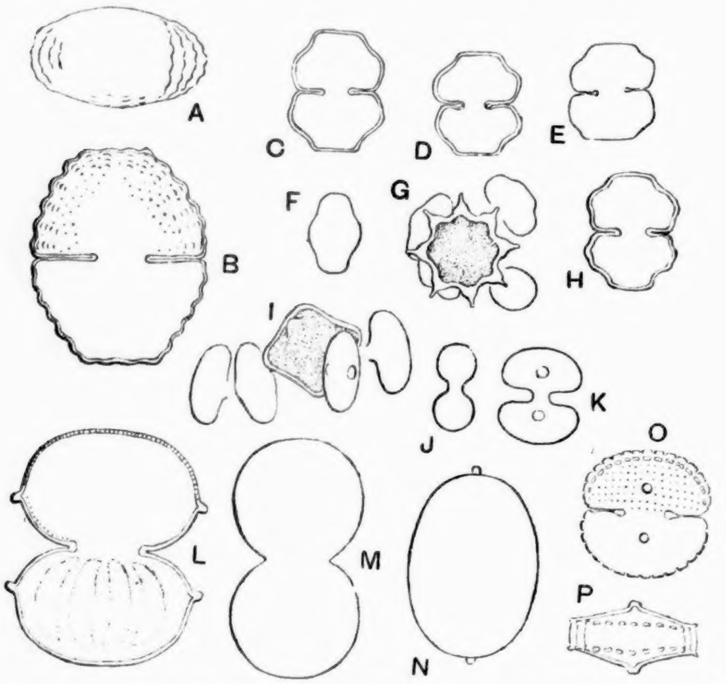

Fig. 14.—*A*, *B*, *Cosmarium obtusatum* Schmidle var. *undulatum* var. nov. *C–H*, *C. Hammeri* Reinsch var. *africanum* Fritsch, forma. *I–K*, *C. ocellatum* Eichl. and Gutw. var. *rotundatum* var. nov. *L–N*, *C. lobatum* Boerg. var. *elliptica* var. nov. *O*, *P*, *C. monomazum* Lund., forma. (All × 650.)

The dimensions agree well with those given by Boergesen for the type. The rounded papilla, on each side of the semicell in front-view and at the poles in end-view, is well marked. The shape of the end-view is, however, distinctive, as is also the scrobiculate membrane. The front-view shows a decided resemblance to *Staurastrum brevispinum* Bréb. forma *major* W. and G. S. West (1912, Pl. CXXIII, fig. 4).

Forma major. Long. cell., 115–120 μ; lat., 80 μ; isthm., 30 μ; crass., 70 μ (6 *b*, 1136 *c*).

Cosmarium maximum (Boerg.) W. and G. S. West, *forma* Fritsch and Rich, 1924, p. 346, fig. 15, *B*.

Long. cell., 80 μ; lat., 70 μ; isthm., circa 20 μ. (Very rare in 75.)

The dimensions are less than in the form described from Natal, and the breadth does not exceed the length.

Cosmarium Meneghinii Bréb.; W. and G. S. West, 1908, p. 90, Pl. LXXII, figs. 29–32.

Long. cell., 15 μ; lat., 11 μ; isthm., 3 μ (72).

A single zygospore observed was globose, and furnished with short acute spines. Recorded from Griqualand West.

Cosmarium moniliforme (Turp.) Ralfs; W. and G. S. West, 1908, p. 20, Pl. LXVII, fig. 2.

Long. cell., 32 μ; lat., 20 μ; isthm., 4 μ (7).

Forma *panduriformis* Heimerl; W. and G. S. West, 1908, p. 22, Pl. LXVII, figs. 8, 9.

A very small form; long., 14–15 μ; lat., 7–9 μ; diam. zygosp., 13–14 μ (6 *b*). The zygospore had a smooth membrane.

Var. *subpyriforme* W. and G. S. West, 1908, Pl. LXVII, fig. 5.

Long., 30–36 μ; lat., 15–18 μ; isthm., 4·5–6 μ; crass., 16 μ; diam. zygosp., circa 30 μ (6 *b*, 1136 *a*). The zygospore had a very thick wall.

Cosmarium monomazum Lund.

Forma membrana punctata.

Long. cell., 26–29 μ; lat., 28–30 μ; isthm., 7–10 μ; crass. max., 14–20 μ (6 *b*, 1134, 1136 *a*). (Fig. 14, *O, P*.)

There are about 16 slightly emarginate and flattened warts just within the margin of the semicell, while the centre is provided with a rather large tubercle. The vertical view has truncate poles, a large median tubercle on each side, and a series of emarginate warts extending from pole to pole just within each lateral margin. The cell-wall is punctate. The dimensions are less than those given by Messrs. West for the type (1908, p. 140).

Cosmarium multiordinatum W. and G. S. West var. *bhurmense* W. and G. S. West.

Long. cell., 84–91 μ; lat., 63–66 μ; isthm., 20 μ; crass., 44 μ (6 *b*, 72).

The warts were rather more numerous and scarcely conical in form, although much more pointed than in the Wests' figure of the type. There were two pyrenoids in each semi-cell.

Cosmarium multituberculatum sp. nov. (Fig. 18, *A–O*).

C. parvum, ca. tam longum quam latum, profunde constrictum, sinu angusto-lineari vel saepe paullo aperto, plerumque introrsum leviter ampliato, pyrenoidibus 2 in quaque semicellula; semicellulae a fronte visae semiellipticae, angulis inferioribus subrectangularibus, lateribus convexis

cum crenis vel spinis parvis 4, apicibus plus minus convexis et leviter undulatis, intra apicem cum tuberculis bene evolutis 2–4 et in superficies cum tuberculis rotundatis in seriebus transversalibus 1–3 dispositis interdum non evolutis; semicellulae a latere visae trapeziformes, apicibus latis truncatis, cum tuberculo in angulo apicali unoquoque et saepe cum tuberculis 1 vel 2 infra angulum apicalem; semicellulae a vertice visae ellipticae, polis rotundatis 1–3-papillatis, lateribus cum tuberculis 3–4 in media parte. Zygosporae polyhedricae, angulis cum spina brevi obtusa. Long. cell., 25–30 μ; lat., 27–32 μ; isthm., 5–7·5 μ; crass., 15–18 μ; diam. zygosp. sine proc., 30 μ; c. proc., 40–50 μ (6 *b*, 7, 72, 1134, 1136 *b*, *c*).

This is a highly variable species allied to *C. taxichondrum* Lund., but all the different forms observed appeared to grade into one another to so marked a degree that a distinction of separate varieties did not appear feasible. The sinus, though generally more or less open, is closed in some individuals (*A*, *D*). The convex lateral margins are provided with 4 prominences which either take the form of mere crenations or appear as well-defined, though small, spines. The apex is more or less convex and slightly undulate. It is in the ornamentation of the surface of the semi-cell that the greatest degree of variability is found. There are always a number of rather pointed tubercles just beneath the apex, commonly 3 or 4 in number (*A*–*C*, *F*), but sometimes there are only 2 (*N*). In some cases these constitute the only ornamentation present, but commonly there are further transverse rows of rather more rounded tubercles on the surface of the semicell, either only one row (*F*) or several (*D*, *N*). The infra-apical tubercles appear also in the end-view (*E*, *G*), while the side-view shows the surface-markings as one or more tubercles at and below the apical angles of the semicells (*J*, *M*). A rather extreme form, in which the subapical tubercles are large and markedly pointed is seen in *L*. Only two zygospores were seen; they were polyhedral, and each angle was surmounted by a short blunt spine.

Cosmarium obtusatum Schmidle: W. and G. S. West, 1908, p. 7.
Var. *undulatum* var. nov. (Fig. 14, *A*, *B*).

Differt a typo semicellulis in aspectu frontali vertice undulato, marginibus lateralibus undulationibus 5 vel 6. Long. cell., 47–55 μ; lat., 42–46 μ; isthm., 12–16 μ (6 *b*, 72, 75).

This variety differs in the fact that the apex is often as markedly undulate as the lateral margins and that the latter possess five or six undulations only. There are two pyrenoids in each semi-cell. The end-view (Fig. 14, *A*) is very similar to that of the type. A form with a faintly undulate apex has already been recorded from the Modder River (Fritsch, 1918, p. 552).

The type has been recorded from the Karoo and the Modder River.

Cosmarium ocellatum Eichl. and Gutw.; W. and G. S. West, 1905, p. 144. Var. *rotundatum* nov. var. (Fig. 14, *I–K*).

Differt a typo semicellulis in aspectu frontali late rotundatis fere semiellipticis, sinu late aperto. Long. cell., 19–24 μ; lat., 18–22 μ; isthm., 3–5 μ; crass., 10 μ; lat. zygospor., 21 μ (6 *b*, 7, 72, 75).

This variety is characterised by the rounded semicells and the widely open sinus. The zygospores observed were polyhedral with rounded angles, and sides measuring between 20 and 30 μ. A similar zygospore has been recorded by Homfeld (1929, p. 47) for the type.

The form of the semicells is like that of some varieties of *C. titho-phorum* Nordst. (= *C. Onychonema* Racib.).

Cosmarium orthostichum Lund. var. *compactum* W. and G. S. West, forma. (Fig. 15, *A–D*.)

Long. cell., 16–21 μ; lat., 17–18 μ; isthm., 5–7 μ; crass., 11 μ; zygospor., 17–20 μ (6 *b*, 72, 75, 1136 *c*).

This form is, in some respects, intermediate between the type and its var. *compactum*. It resembles the latter in dimensions and the possession of a closed sinus, but the granules are less numerous, and although those in the centre of the semicell are sometimes larger than those near the edge this is not always so. In the end-view about 5 transverse rows of granules each comprising 3 or 4 are seen. The cells were sometimes found in short rows; in other cases large numbers of individuals, in part arranged in pairs, occurred embedded in mucilage. The zygospore is dark brown in colour; it is spherical, and furnished with bi- (or tri-) furcate spines. Zygospores of this species have not previously been described.

Cosmarium Pappekuilense G. S. West, forma. (Fig. 15, *E–G*.)

Long. cell., 27–34 μ; lat., 25–31 μ; isthm., 8–10 μ; crass., 17–20 μ (rather common in 6 *b*, 72, 75, 1134, 1136 *a*, *c*).

The rather coarse granules, which are sometimes emarginate, were arranged in about 8 vertical and 5 horizontal rows.

This form approaches that previously recorded from Griqualand West.

Cosmarium pericymatium Nordst. Var. *latior* var. nov. (Fig. 15, *H–J*).

Differt a typo semicellulis latioribus, constrictione profundiori, undulationibus marginis semicellulae plus numerosis. Pyrenoidibus in quaque semicellula 2. Long. cell., 44–48 μ; lat., 31–37 μ; isthm., 19–21 μ; crass., 27–28 μ (6 *b*).

This variety differs from the type in the broader semicells, the deeper constriction, and the more numerous undulations round the margin of the semicell. There are two pyrenoids in each semicell. The cell-wall is densely punctate. The vertical view is like that of the type. The type has been recorded from the Transvaal.

Cosmarium Portianum Arch.; Taylor, 1934, Pl. LIII, fig. 4.

Long. cell., 20–25 μ; lat., 18–22 μ; isthm., 6 μ; crass., 10–12 μ (72, 75, 1134).

In dimensions the individuals agree with the tropical forms of *C. Portianum* which are said to be considerably smaller than those occurring in temperate regions (W. and G. S. West, 1908, p. 167). Previously recorded from Equatorial Africa and Southern Rhodesia.

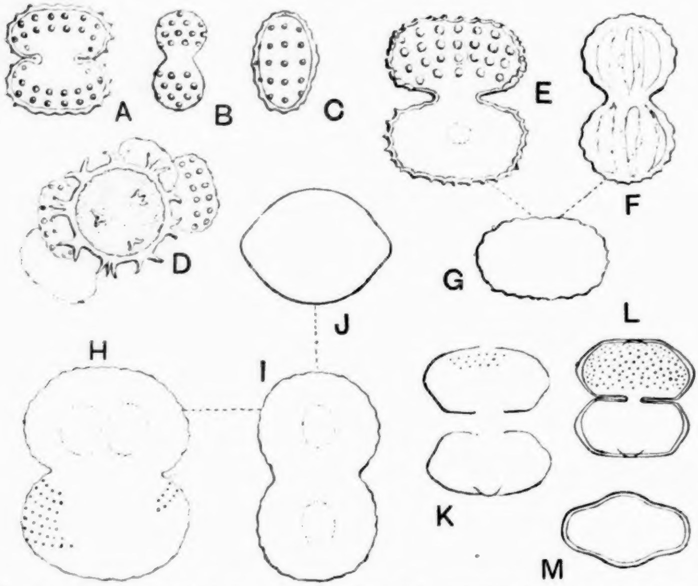

FIG. 15.—*A–D*, *Cosmarium orthostichum* Lund. var. *compactum* W. and G. S. West, forma ($\times$ 1000). *E–G*, *C. Pappekuilense* G. S. West, forma ($\times$ 800). *H–J*, *C. pericymatium* Nordst. var. *latior* var. nov. ($\times$ 700). *K–M*, *C. pseudobiremum* Boldt var. *punctatum* var. nov, ($\times$ 800).

Cosmarium pseudobiremum Boldt.

Var. *punctatum* var. nov. (Fig. 15, *K–M*).

Differt a typo isthmo angustiori, tuberculo mediano in aspectu frontali majore, membrana delicate punctata.

Long. cell., 24–27 μ; lat., 25–27 μ; isthm., 5–6 μ; crass., 15–16 μ (6 *b*, 72).

This variety differs from the type in its narrower isthmus, in the greater prominence of the median protuberance, and the delicately punctate cell-wall. The protuberance usually projects a little beyond the apex, giving the middle of the latter a curiously interrupted appearance in front-view.

The side-view of the semicell seems to be circular with a somewhat flattened apex.

Cosmarium pseudo-exiguum Racib.; W. and G. S. West, 1908, p. 65, Pl. LXX, fig. 25.

Long. cell., 24–27 μ; lat., 11–13 μ; isthm., 3·5–4 μ; crass., 7–8 μ (6 *b*, 72, 1136 *a*).

The apex is subtruncate, sometimes faintly retuse, and the lateral margins are parallel. The semicells in side-view are elliptic.

Cosmarium pseudopachydermum Nordst.

Var. *incrassata* var. nov. (Fig. 16, *A*, *B*).

Differt a typo dimensionibus minoribus, apice in aspectu frontali subrotundato et incrassato; in aspectu laterali semicellulis in media parte cum membrana valde incrassata. Long. cell., 90–102 μ; lat., 52–62 μ; isthm., 17–20 μ; crass., 45–46 μ (6 *b*, 7, 72, 1136 *b*).

The general form of the cell in front-view is like that in Nordstedt's figure of the type (1888, p. 53, fig. 20 *a*), but the apex is not truncate, being somewhat rounded. At the apex the membrane is markedly thickened, while a still more pronounced thickening occurs over the middle part of each semicell, as is clearly seen in the side-view (Fig. 16, *B*). The end-view is much as in the type except for the special thickening of the wall. The latter is thick and scrobiculate throughout. There are two pyrenoids in each semicell.

Cosmarium pseudoprotuberans Kirchn.

Formae pro parte ad var. *alpinum* Racib. accedentes. Long. cell., 17–18 μ; lat., 13–16 μ; isthm., circa 4 μ; crass., 7–8 μ (6 *b*, 7, 72, 75). (Fig. 18, *T*, *U*.)

Most of the forms present show the upper lateral margins practically merged in the apex, which is generally uniformly convex; the greatest width of the semicell comes just below the apex. These forms, though smaller, resemble var. *angustius* Nordst., and also approach var. *alpinum* Racib. in their wide apex. Other forms present, though showing smaller dimensions than are given by Messrs. West for the type, correspond to their fig. 7 (1908, Pl. LXXII) except for having a more closed sinus.

Var. *retusiforme* var. nov. (Fig. 18, *V*).

Differt a typo apice semicellulae in aspectu frontali retuso. Long. cell., 12–16 μ; lat., 10–12 μ; isthm., circa 3 μ (6 *b*).

The sides are upwardly diverging, as in the type, the greatest width being above the middle of the semicell; the convex apex is retuse in the middle. The side-view of the semicell is circular. There is some resemblance to *C. sexangulare* Lund. forma *minima* Nordst., but the lower lateral margins are longer than the upper ones.

Cosmarium pseudopyramidatum Lund.

Forma marginibus lateralibus solum leviter convexis, apice obscure truncato interdum subretuso. Long. cell., 51–59 μ; lat., 32–36 μ; isthm., 8–10 μ; zygospor., 46–47 μ (6 *b*, 7, 72, 1136 *a*, *c*). (Fig. 16, *C–E*.)

The lateral margins in this form are only slightly convex, and the apex

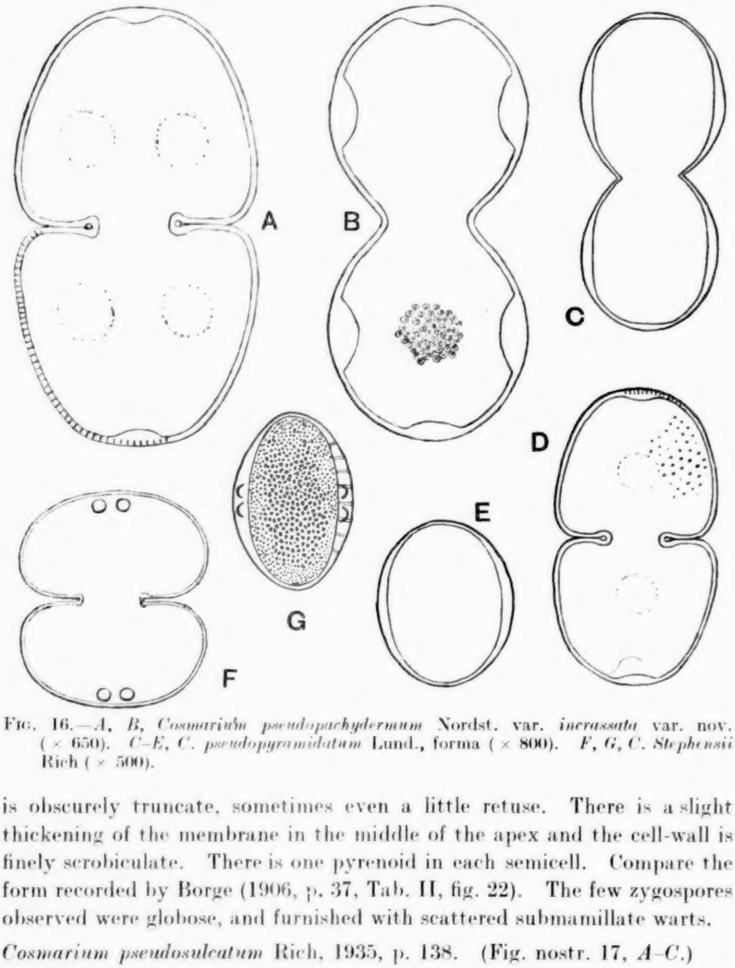

Fig. 16.—*A*, *B*, *Cosmarium pseudopachydermum* Nordst. var. *incrassata* var. nov. (× 650). *C–E*, *C. pseudopyramidatum* Lund., forma (× 800). *F*, *G*, *C. Stephensii* Rich (× 500).

is obscurely truncate, sometimes even a little retuse. There is a slight thickening of the membrane in the middle of the apex and the cell-wall is finely scrobiculate. There is one pyrenoid in each semicell. Compare the form recorded by Borge (1906, p. 37, Tab. II, fig. 22). The few zygospores observed were globose, and furnished with scattered submamillate warts.

Cosmarium pseudosulcatum Rich, 1935, p. 138. (Fig. nostr. 17, *A–C*.)

Long. cell., 41–49 μ; lat., 31–36 μ; isthm., 8–10 μ; crass., 25–28 μ; lat. apic., 18 μ (6 *b*, 72, 1134, 1136 *a*, *b*).

This *Cosmarium* is no doubt the same as the one described from Southern Rhodesia under the above name. In the earlier material the number of apical tubercles could not be exactly ascertained. Examination of the present material has shown that there are usually two median closely approximated tubercles just below the apex on either face of the semicell, while a further tubercle generally occurs at each apical angle. The distribution is plainly seen in the end-view (Fig. 19, *C*). The tubercles, however, vary in number and degree of development, and the thickened lateral angles probably represent other less pronounced tubercles. The membrane is always rather thick. The annular thickening at the isthmus was fre-

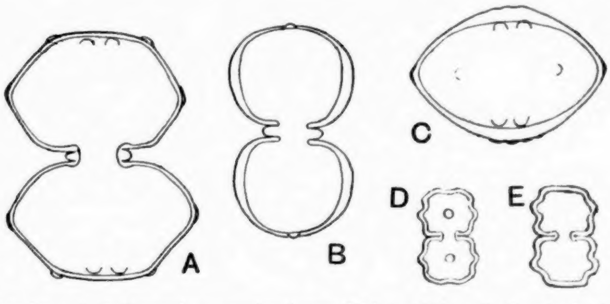

FIG. 17.—*A–C*, *Cosmarium pseudosulcatum* Rich (× 800). *D*, *C. subreinschii* Schmidle; *E*, *C. subreinschii* var. *ocellatum* W. and G. S. West (× 750).

quently observed (though not figured) in the Rhodesian material; in the specimens found in the Belfast Pan this thickening is almost invariably present. The apex of the semicell is usually slightly convex, but sometimes almost truncate. The upper lateral margins are often slightly retuse.

Cosmarium rectangulare Grun. var. *hexagonum* (Elfv.) W. and G. S. West.

Forma marginibus lateralibus inferioribus leviter divergentibus. Long. cell., 30 μ; lat., 23 μ; isthm., 6–7 μ; crass., 16 μ (75). (Fig. 18, *P*, *Q*.)

Cells about $1\frac{1}{4}$ times as long as broad, deeply constricted, sinus very narrow with a slightly dilated apex; semicells subhexagonal, the six angles rounded and the wall at these places slightly thickened. Lower lateral margins slightly upwardly divergent. Apex truncate and straight. Side-view of semicell obovate-circular.

Varieties of this species have been recorded from Central Africa, the Cape Peninsula, and Kentani.

Cosmarium Regnellii Wille.

Long. cell., 13 μ; lat., 11 μ (75).

Previously recorded from S. Africa.

Cosmarium Regnesi Reinsch; W. and G. S. West, 1908, p. 36, Pl. LXVIII, figs. 19–22.

Long. cell., 10 μ; lat., 11 μ; isthm., 4 μ (6 *b*, 7, 72).

Zygospores were observed.

A variety of this species has been recorded several times from S. Africa.

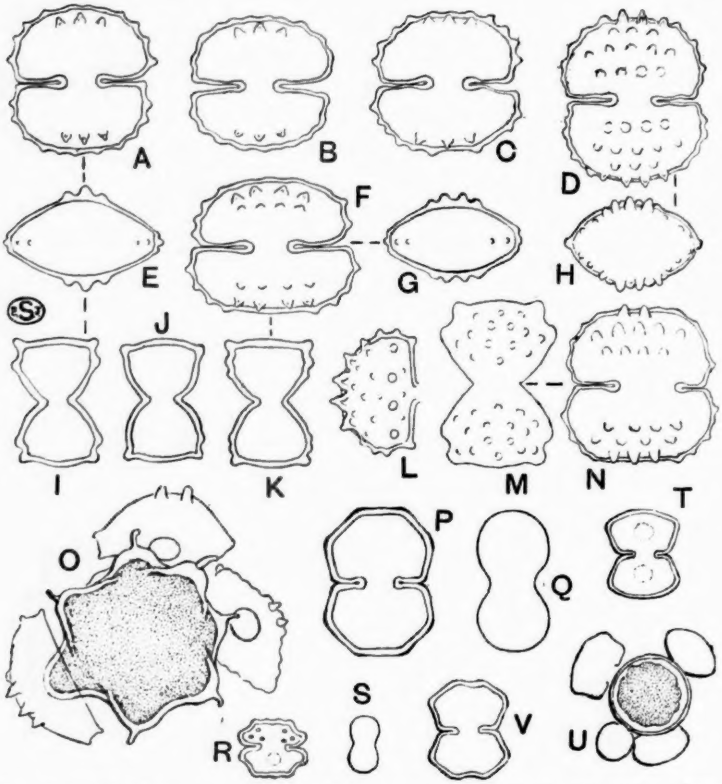

FIG. 18.—*A–O*, *Cosmarium multituberculatum* sp. nov. *P*, *Q*, *C. rectangulare* Grun. var. *hexagonum* West, forma. *R*, *S*, *C. subhumile* Rich var. *reductum* var. nov. *T*, *U*, *C. pseudoprotuberans* Kirchn., forma. *V*, *C. pseudoprotuberans* var. *retusiforme* var. nov. (All × 750.)

Cosmarium Salisburii sp. nov. (Fig. 12, *A–D*).

C. mediocre, circa $1\frac{1}{3}$ plo longius quam latum, profunde constrictum, sinu angusto-lineari introrsum ampliato, pyrenoidibus 2 in quaque semicellula; semicellulae a fronte visae subsemicirculares, angulis inferioribus subrectangularibus, lateribus convexis crenatis, apicibus subtruncatis planis

in angulum apicalem utrumque cum papillo conico parvo, intra apicem serie verrucarum 7–8, in superficiem semicellulae cum verrucis retusis rotundatis in seriebus transversalibus indistinctis 3 dispositis, granulis 5 circum verrucam unamquamque, membrana minute punctata; semicellulae a latere visae subpyriformes, apicibus leviter rotundatis, lateribus cum verrucis retusis 3 vel 4, intra marginem serie verrucarum similium; semicellulae a vertice visae ellipticae, polis bipapillatis, lateribus undulatis cum verrucis alternantibus, intra marginem serie verrucarum 7 vel 8 et in parte mediana papillo singulo et polos versus cum papillis 2. Zygosporae (immaturae) magnae rotundatae, membrana crassa, margine undulato.

Long. cell., 50–59 μ; lat., 38–44 μ; isthm., 11–13 μ; crass., 30–33 μ; diam. zygosp., circa 50–60 μ (6 *b*, 72, 1136 *a*, *b*, *c*).

This highly ornamented species, as seen in front-view (Fig. 12, *A*), bears a series of warts just beneath the apex of the semicell, and on the surface a considerable number of further warts, arranged roughly in three transverse series, and leaving a bare area of variable extent above the isthmus. The warts are, in general, rounded (sometimes slightly oval) and retuse, with a rather small apical depression. Around each wart is a series of 5 small granules regularly disposed, and a few isolated granules may also be found on the part of the semicell above the isthmus; the rest of the membrane is finely punctate. The sides of the semicells are crenated, the crenations often becoming less marked towards the apex. The latter is quite smooth and almost flat, but at each apical angle there is a small conical papilla.

In end-view (Fig. 12, *C*) the infra-apical warts are seen as two series extending on either side of the axis joining the poles; there is also evident a central papilla, and near each pole are two papillae one in front of the other. The warts, seen on the surface of the semicell in front-view, appear here along the margin. In side-view (Fig. 12, *B*) the lateral margins show two or three emarginate warts belonging to the three transverse series seen on the face of the semicell in front-view. No mature zygospores were found, so that the undulate outline shown in Fig. 12, *D* may not be typical of the ripe condition.

In certain respects this species recalls *C. elaboratum* W. and G. S. West (1895, p. 69, Pl. VII, fig. 15), in which, however, the apex is not plane, and the warts on the surface of the semicell are lacking.

Cosmarium Stephensii Rich, 1932, p. 172. (Fig. 16, *F*, *G*.)

Long. cell., 60–70 μ; lat., 40–60 μ; isthm., 15–20 μ; crass., 32–41 μ (6 *b*, 72, 1136 *a*, *b*).

This species was described from the Weltevreden West Pan (Transvaal) in 1932, but in that material the markings could not be clearly discerned. The surface is covered with scrobiculations, each of which is seated in the middle of a polygonal areolation. A short distance below the apex of each semicell, as seen in front-view, are two blunt knobs more or less

symmetrically placed: the three shown in Fig. 9, *B* of the earlier record are due to misinterpretation. The position of the knobs is well seen in the end-view (Fig. 16, *G*), which also shows that the wall of the semicell is strongly thickened over the middle part of each face. There are two pyrenoids in each semicell. In the presence of the two blunt processes beneath the apex of the semicell this species resembles *C. mamilliferum* Nordst. var. *madagascariense* W. and G. S. West. Previously recorded from the Transvaal.

Cosmarium subcrenatum Hantzsch.

Long. cell., 40 μ; lat., 25–26 μ; isthm., 12 μ; crass., 15 μ (72).

The lateral margins and the apex of the semicells are provided with 4 crenations within each of which lies a binate granule. The central granules are ill-defined, rather as in Pl. LXXXVI, fig. 15 of West (1908). Previously recorded from E. and Central Africa.

Cosmarium subhumile Rich, 1935, p. 141, fig. 10, *A–C*.

Var. *reductum* var. nov. (Fig. 18, *R*, *S*).

Differt a typo spinis non evolutis. Long. cell., 10 μ; lat., 11–13 μ; isthm., 3 μ (6 *b*, 75).

Individuals resembling this variety in the absence of spines were observed in the collection from the Transvaal examined in 1932, but, in view of their scarcity, were not recorded.

The type recorded from Southern Rhodesia.

Cosmarium subreinschii Schmidle (Fig. 17, *D*).

Long. cell., 19–21 μ; lat., 13–15 μ; isthm., 3 μ (7, 1134, 1136 *b*).

This species is characterised by its sinuous lateral margins. Some semicells in front-view show a single crenation on each side, while others show faint indications of a second. The side-view of the semicell is narrowly elliptic.

Certain resemblances are shown to *C. dubium* Borge and to *C. subimpressulum* Borge, but these have not got the general square shape of the semicells which distinguishes *C. subreinschii*.

Var. *ocellatum* W. and G. S. West (Fig. 17, *E*).

Long. cell., 19–25 μ; lat., 15–17 μ; isthm., 4–6 μ (6 *b*, 72).

There is only one crenation on each side, and the apex is broadly truncate.

Cosmarium tinctum Ralfs.

Long. cell., 9–11 μ; lat., 8–11 μ; isthm., 5–8 μ; crass., 5–6 μ; zygospor., 8×11 μ, 10×12 μ, 11×13 μ (6 *b*, 7, 72, 75).

All the individuals seen were colourless, which is unusual, but not unknown, for this species. The characteristic subquadrate zygospores, with rounded angles and retuse sides, were common.

Cosmarium transvaalense sp. nov. (Fig. 13, *F–H*).

C. submediocre, circa $1\frac{1}{3}$ plo longius quam latum, profunde constrictum, sinu angusto-lineari, pyrenoidibus 2 in quaque semicellula; semicellulae

a fronte visae subsemicirculares, angulis basalibus subrectangularibus, lateribus marginalibus 5-crenatis, apice plano truncato, angulis apicalibus cum membrana leviter incrassata, intra apicem verrucis 4, in superficiem semicellulae verrucis similibus pluribus in series indistinctas transversas dispositis, membrana glabra; semicellulae a latere visae subquadratae, papillis rotundatis pluribus in superficiem; semicellulae a vertice visae ellipticae, margine crenato in media parte cum verrucis deplanatis vel emarginatis 3, papillis rotundatis pluribus in superficiem. Long. cell., 30–36 μ; lat., 22–28 μ; isthm., 5–8 μ; crass., 16–21 μ (6 *b*, 72, 75, 1136 *b*).

The actual apex of the semicell is smooth and truncate.

The apical angles have a somewhat thickened membrane and the sides of the semicells are provided with about five rounded crenations. Just within the apex, as seen in front-view, are four warts, and on the face of the semicell are two further indistinct transverse series of warts. In side-view the semicells are somewhat subquadrate, while the end-view is elliptical. The markings in all aspects are rather variable.

There is not much general resemblance to any described species of *Cosmarium*. The side-view is rather like that of *C. mammillatum* Borge (1903, p. 99, Tab. III, fig. 28), but the front- and end-views of this species are markedly different. It may also be compared to *C. ceratophorum* Lütkem. and *C. Burkillii* West.

Genus Xanthidium Ehrenberg.

Xanthidium concinnum Arch.; W. and G. S. West, 1912, Pl. CXII, fig. 10.

Long. cell., 10 μ; lat., 9·5 μ. (Rather rare in 6 *b*.)

Recorded for Weltevreden West Pan (Transvaal).

Xanthidium decoratum sp. nov. (Fig. 19, *A–C*).

X. mediocre, circa $1\frac{1}{4}$ plo longius quam latum, profunde constrictum, sinu lineari; semicellulae a fronte visae pyramidatae, angulis inferioribus rectangularibus, marginibus lateralibus convexis cum serie spinarum 4, apicibus latis convexis spina majore valida ad angulum superiorem unumquemque, verrucis truncatis 4–5 infra apicem, in superficiem semicellulae tumoribus superioribus 3, inferioribus 4, cum granulo centrali 1 et granulis periphericis 8–10, granulis inter tumores hexagonaliter dispositis; semicellulae a latere visae circulares, cum spina valida acuta apicali, marginibus lateralibus tumoribus rotundatis 2 vel 3 et intra marginem cum tumoribus similibus diverse dispositis; semicellulae a vertice visae ellipticae, polis bipapillatis, tumoribus rotundatis pluribus superpositis in marginibus lateralibus et intra marginem verrucis truncatis 4 vel 5, spina valida polos versus utrobique.

Long. cell., 48–54 μ; lat., 38–44 μ; isthm., 10–12 μ; crass., 33 μ; ong. spin. apic., 7–8 μ (6 *b*, 7, 72).

This species is characterised by (*a*) the marked and sometimes curved spines at the apical angles of the semicells, (*b*) the row of truncate verrucae just beneath the apex on either face of the semicell (cf. the end-view, Fig. 19, *B*), and (*c*) the two approximately transverse rows of tumours on the face of the semicell (very conspicuous along the lateral margins of the end-view, and also along the margins of the side-view, Fig. 19, *C*), each

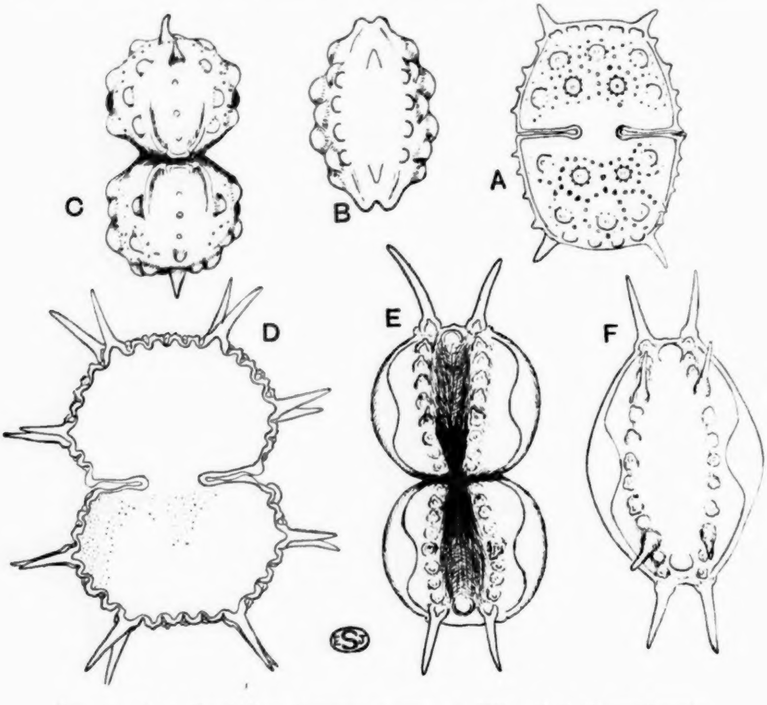

FIG. 19.—*A–C*, *Xanthidium decoratum* sp. nov. (× 300). *D–F*, *X. sansibarense* Schmidle, forma *major*.

tumour bearing one central and 8–10 peripheral granules; other granules are disposed in a hexagonal pattern between the tumours. It appears that the spines at the apical angles may occasionally be forked, or in other specimens they may be strongly reduced and scarcely more prominent than those on the lateral margins of the semicells.

In the side- and end-views there is some resemblance to *X. quadridentatum* W. and G. S. West (1902, p. 160, Pl. XX, fig. 21), but *X. decoratum* has a different front-view and is decidedly more ornate.

Xanthidium sansibarense (Hieron.) Schmidle.

Forma major. Long. cell., 100–110 μ; lat., 68–87 μ; isthm., 21 μ; crass., 52–60 μ; diam. verruc., 5–6 μ, altit., 3–4 μ; long. spin., ad 24 μ (6 *b*, 72, 1136 *a*). (Fig. 19, *D–F*.)

These specimens are considerably larger than those previously recorded. Apart from the characteristic paired spines situated at the lateral and apical angles of the semicells, there is a series of warts just within the margin of the semicell, 4 beneath the apex, 3 within the superior lateral and about 3 within the inferior lateral margins. The warts in general have a truncate or even slightly emarginate apex, but occasional ones within the lateral margins may be produced into a small prominence. The lateral angles occasionally bear 3 spines. The face of the semicell is devoid of ornamentation, but the entire membrane is finely punctate. The side- and end-views show that the membrane is strongly thickened over the middle of the semicell, but this is not apparent in the front-view.

Genus ARTHRODESMUS Ehrenberg.

Arthrodesmus bifidus Bréb. var. *inaequispinosus* Huber-Pestalozzi, 1930, p. 467, Tab. VII, fig. 5.

Long. cell., 8–9·5 μ; lat. (sine spin.), 9–10 μ; isthm., 3 μ (7, 72).

The cells are small, about as long as wide and deeply constricted; the sinus is widely open. The sides diverge upwards and the apex is slightly concave, terminating laterally in an upturned spine; the lateral angles are produced to form an almost horizontal spine, longer than the apical ones. Vertical view elliptic, with one straight spine at each rounded pole.

Previously recorded for the Knysna Forest (S. Africa).

Arthrodesmus mucronulatus Nordst., forma W. and G. S. West, 1895, p. 72, Pl. VIII, fig. 16; Borge, 1903, p. 102, Tab. III, fig. 36. (Fig. 20, *A*.)

Long. cell., 34–36 μ; lat. (sine spin.), 43–45 μ; isthm., 12 μ (7, 72, 1136).

This Desmid shows some resemblance to *Xanthidium subhastiferum* West, but differs from it in possessing two pyrenoids in each semicell, in the greater relative breadth, in the possession of a punctate membrane, and in a different arrangement of the spines.

Arthrodesmus quiriferus W. and G. S. West.

Var. *evolutus* var. nov. (Fig. 20, *C*).

Differt a typo magnitudine minore, isthmo elongato concavo, dente minuto in angulum basalem unumquemque semicellulae.

Long. cell., 12 μ; lat. cum proc., 24 μ; isthm., 4 μ. (Very rare.)

The concave isthmus is more elongated than in the type and each

lateral angle of the semicell is provided with a slight projection. This variety is decidedly smaller than any form of *A. quiriferus* hitherto described.

Arthrodesmus subulatus Kütz.

Var. *validus* nov. comb. (Syn.: *A. incus* (Bréb.) Hass. var. *validus* W. and G. S. West.) (Fig. 20, *D, E.*)

Differt a typo magnitudine paullo minore, spinis apicalibus valde divergentibus. Zygosporis globosis, membrana laevi. Long. cell. (sine

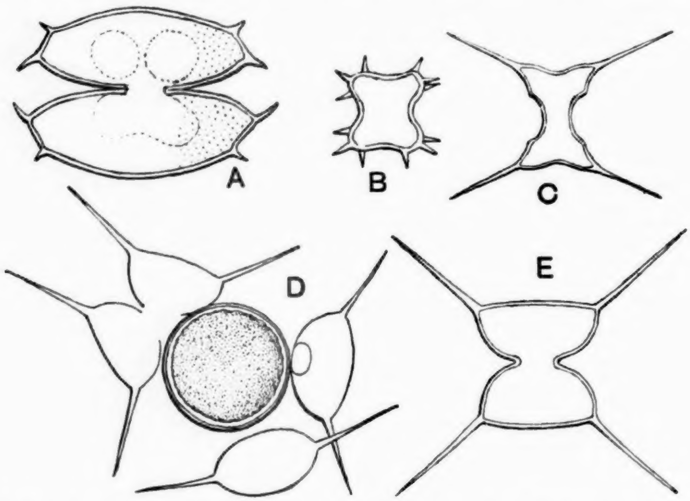

FIG. 20.—*A*, *Arthrodesmus mucronulatus* Nordst., forma. *B*, *Arthrodesmus trispinatus* West. *C*, *A. quiriferus* West var. *evolutus* var. nov. *D*, *E*, *A. subulatus* Kütz. var. *validus* West. (*C* × 1200, the rest × 750.)

spin.), 23–26 μ; lat. (sine spin.), 22–25 μ; isthm., 7–8 μ; crass., 14 μ; long. spin., 20 μ; diam. zygospor., 26–27 μ (72, 1134, 1136 *c*).

This variety differs from the type in being a little smaller, and in possessing markedly divergent spines. It agrees exactly with the type in the shape of the semicells and the possession of a globose zygospore with a smooth wall.

In vegetative characters there is nothing to distinguish this variety from *A. incus* (Bréb.) Hass. var. *validus* W. and G. S. West, except for slightly smaller dimensions. *A. incus* has a zygospore which is provided with short spines, and the discovery of a smooth zygospore in this variety warrants its removal from *A. incus* and reference to *A. subulatus*.

A form of this variety has been recorded from S. Rhodesia.

Arthrodesmus triangularis Lagerh., forma *triquetra* W. and G. S. West, 1912, p. 99, Pl. CXXVIII, fig. 16.

Long. cell., 16 μ; lat. (cum spin.), 32 μ; isthm., 4–5 μ (75).

The vertical view is triangular with retuse sides. In some cases the spines in front-view are directed upwards. The membrane is smooth.

Arthrodesmus trispinatus W. and G. S. West. (Fig. 20, *B*.)

Long. cell. (sine sp.), 14 μ; lat., 15 μ; isthm., 12 μ. (Rare in 6 *b*, 1136 *b*.)

The three spines on each side of the semicell are not all in the same plane, as has been noticed by Deflandre (1924, p. 916). The latter author gives no dimensions for the form observed by him.

Genus Staurastrum Meyen.

Staurastrum americanum (W. and G. S. West) Smith, 1922, p. 351.

Var. *elaboratum* var. nov. (Fig. 21, *B*).

Semicellulis apice plus minus convexo, verruca emarginata vel bidentata utrobique in parte basali brachiorum semicellulae. Long. cell. sine proc., 20–22 μ; lat. cum proc., 60–70 μ; isthm., 6–7 μ (7, 1136 *c*).

This biradiate form does not seem hitherto to have been described. The individuals were rare and we have been in some difficulty in arriving at a final decision regarding them. They would, however, appear to constitute an elaboration of the type of *S. grallatorium* Nordst., and in particular of var. *americanum* W. and G. S. West (1896, p. 265, fig. 15) which Smith (loc. cit.) regards as a separate species. There is considerable resemblance to the var. *longiradiatum* G. M. Smith (1922, p. 352, Tab. XI, figs. 10, 11), but the apex and sinus in our specimens are more elaborate as a result of the development of an emarginate or bidentate process on each side of the basal parts of the arms. The latter terminate in 2 or 3 teeth.

Staurastrum anatinum Cooke and Wills.

Long. cell., 40 μ; lat. cum proc., 70 μ; isthm., 14 μ (1136 *b* and *c*).

Staurastrum brachioprominens Boerg. var. *Archerianum* Bohlin.

Forma minor, brachiis pro ratione longioribus, margine inferiori semicellulae evidenter convexo. Long. cell., 18–19 μ; lat. cum proc., 44–58 μ; isthm., 5–6 μ (6 *b*, 72, 75). (Fig. 21, *A*.)

The cells have but a slight constriction, which usually appears as a notch. The basal part of the semicell is inflated and has a convex margin. Two emarginate verrucae are inserted just below the apex, while the long processes are slender and slightly divergent, with seven or eight denticulations, and three small apical spines. The vertical view is fusiform or oblong and biradiate.

The differences from var. *Archerianum* are only slight. The cells are

smaller, and the processes relatively longer. In the inflation of the basal parts of the semicells it resembles *S. asperatum* Grönbl., which is smaller and, at present, only known to be triradiate. There is also appreciable resemblance to *S. dimazum* (Lütkem.) Grönbl., but this has a more complex ornamentation.

Staurastrum brevispinum Bréb.: W. and G. S. West, 1912, p. 145, Pl. CXXIII, fig. 1.

Rather small forms (7).

Previously recorded from Weltevreden West (Transvaal).

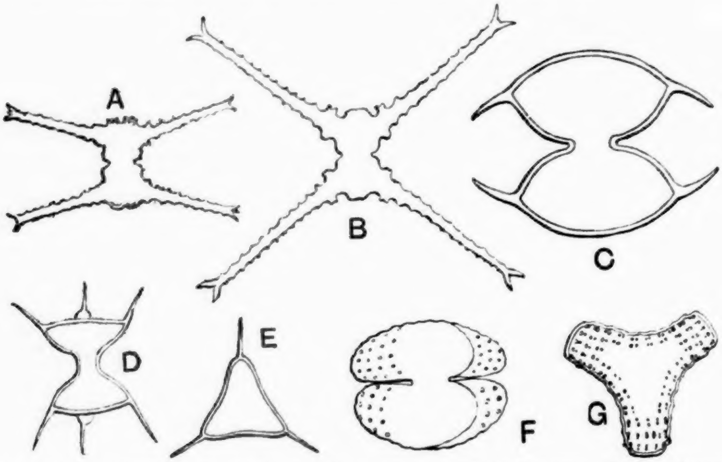

FIG. 21.—*A*, *Staurastrum brachioprominens* Boerg. var. *Archerianum* Bohlin, forma *minor*. *B*, *Staurastrum americanum* Smith var. *elaboratum* var. nov. *C*, *Staurastrum Dickiei* Ralfs, forma *longispina*. *D–E*, *Staurastrum cuspidatum* Bréb. var. *divergens* Nordst., forma. *F*, *G*, *Staurastrum Doidgei* sp. nov. (All × 780.)

Saturastrum Clepsydra Nordst. var. *obtusum* Nordst.; F. Rich, 1932, fig. 10, *C*. (Syn.: *S. pachyrhynchum* Nordst., forma Borge, 1903.)

Long. cell., 20 μ; lat., 23 μ (1136 *a* and *b*).

Previously recorded from the Transvaal.

Staurastrum curvatum West: West and Carter, 1923, p. 19, Pl. CXXX, fig. 15.

Long. cell. sine proc., 28 μ; lat. cum proc., 34 μ; isthm., 5–6 μ. (Rare in 6 *b*, 7.)

Staurastrum cuspidatum Bréb.: West and Carter, 1923, p. 23, Pl. CXXXII, figs. 13–15.

Long. cell., 19–24 μ: lat. cum spin., 25–35 μ; isthm., 4–5 μ; diam. zygosp. sine spin., 21 μ (7, 72, 75).

In some cells the spines were converging, in others almost parallel.

Recorded from Central Africa.

Var. *divergens* Nordst.; West and Carter, 1923, p. 25, Pl. CXXXII, fig. 16.

Forma. Long. cell., 15–18 μ; isthm., 3–4 μ (72, 1136 *a* and *c*). (Fig. 21, *D*, *E*)..

The form present was very small, with markedly divergent spines and an elongated isthmus. Vertical view triangular, with concave sides.

Staurastrum Dickiei Ralfs.

Forma *longispina* form. nov. Long. cell., 33–38 μ; lat. sine spin., 29–32 μ; long. spin., 9 μ; isthm., 10 μ (6 *b*, 7, 72, 75). (Fig. 21, *C*.)

The spines are about twice as long as in the type and converge to a marked extent. The end-view is triangular, with slightly concave sides. The membrane is punctate.

The type has been recorded from Central Africa, and a variety from the Transvaal.

Staurastrum Doidgei sp. nov.* (Fig. 21, *F*, *G*).

S. parvum cosmariiforme, paullo latior quam longum, profunde constrictum, sinu angusto-lineari extremo ampliato, chromatophora singula, pyrenoide 1 in quaque semicellula; semicellulis a fronte visis late ellipticis, angulis basalibus late rotundatis, membrana granulis pro parte emarginatis longitudinaliter dispositis obtecta, in parte centrali laevi; semicellulis a vertice visis triangularibus, angulis obtusis fere truncatis, lateribus valde concavis, granulis in processibus et intra margines laterales transverse et longitudinaliter dispositis. Long. cell., 27 μ; lat., 29–31 μ; isthm., 7 μ. (Rare in 75.)

This is seemingly a new type among the cosmarioid *Staurastra*. There is some resemblance in the end-view to *S. maamense* Arch., but the front-view is altogether different.

Staurastrum excavatum W. and G. S. West, 1895, p. 78, Pl. VIII, fig. 42. (Fig. nostr. 22, *E*.)

Long. cell., 10 μ; lat., 48–53 μ; isthm., 5–6 μ (72, 1136 *a*).

This species is characterised by the excavate apex and the slightly divergent and slender arms which show several series of denticulations. The form here recorded is a little shorter than the type and hence has a more depressed appearance.

S. excavatum was first described from Madagascar.

Staurastrum furcatum Ehrenb.

Forma *minor*. Long. cell., 17–20 μ; lat. cum proc., 34–36 μ; isthm., 10–11 μ (1136 *a*, *b*). (Fig. 24, *C–E*.)

The vertical view was often quadrangular (Fig. 24, *E*). As pointed

* Named after Dr. Doidge who has furnished us with these samples.

out by Carter (West and Carter, 1923, p. 176), *S. furcatum* is closely allied to *S. senarium* (Ehrenb.) Ralfs, which appears as a more elaborate development of the type seen in the former.

Forma Rich, 1932, p. 175, fig. 11, *A–C*.

This is characterised by the presence of a simple spine on the ventral margin of the semicell.

Staurastrum gracile Ralfs.

Diam. zygosp. sine spin., circa 30 μ; cum spin., circa 75 μ (1134).

The zygospores, present in one sample, were spherical and provided with numerous spines possessed of a swollen base and divided into 3 bifurcate branchlets at the apex.

Staurastrum inconspicuum Nordst.

A small form. Long. cell. sine proc., 10 μ; lat. sine proc., 6 μ; cum proc., 17 μ. (Rather rare in 1134, 1136 *c*.)

Staurastrum Johnsonii W. and G. S. West, 1896, p. 266, Pl. XVII, fig. 16.
Var. *altior* var. nov. (Fig. 22, *A*, *B*).

Differt a typo magnitudine majore, verrucis apicalibus emarginatis haud tridentatis infra apicem dispositis, marginibus lateralibus semicellulae fere parallelis; semicellulis a vertice visis triradiatis, interdum biradiatis. Long. cell., 54–64 μ; lat. cum proc., 128–164 μ; isthm., 11–12 μ (6 *b*, 7, 72, 1136 *c*).

One of the characteristics of the species, the slight enlargement of the semicell above the isthmus upon which a pair of granules is borne, is well seen in Fig. 22, *A*; in some individuals, however, the granules on this basal enlargement were lacking. The apical warts do not occupy the actual margin, but are placed just within it; they are, moreover, flattened or emarginate, and not tridentate as in the type. The individuals are usually triradiate, and the long arms are provided with numerous series of denticulations. The lateral margins of the semicells are longer than in the type, straight above the basal inflation and practically parallel. G. M. Smith (1924, Pl. XVIII, fig. 4) has figured individuals which resemble ours in the last two respects.

The only triradiate variety of the species hitherto described is var. *triradiatum* Smith (1924, p. 139, Pl. XVIII, figs. 5–7), in which the semicells differ in shape from those here recorded. The specimens may also be compared with *S. subjohnsonii* Rich and *S. longebrachiatum* Gutw.

Staurastrum laevispinum Biss.
Var. *abbreviata* var. nov. (Fig. 22, *C*, *D*).

Differt a typo brachiis brevioribus latioribus obtusis, isthmo angustiori. Long. cell., 24–27 μ; lat., 25–32 μ; isthm., 6 μ (6 *b*, 7, 1136 *a*).

This variety differs from the type in the shorter and relatively broader arms of the semi-cells which are bluntly rounded at the ends where the

membrane is slightly thickened. The isthmus, too, is narrower and rather more elongate, in this respect approaching *S. sublaevispinum* W. and G. S. West. The membrane is quite smooth. A single zygospore was observed;

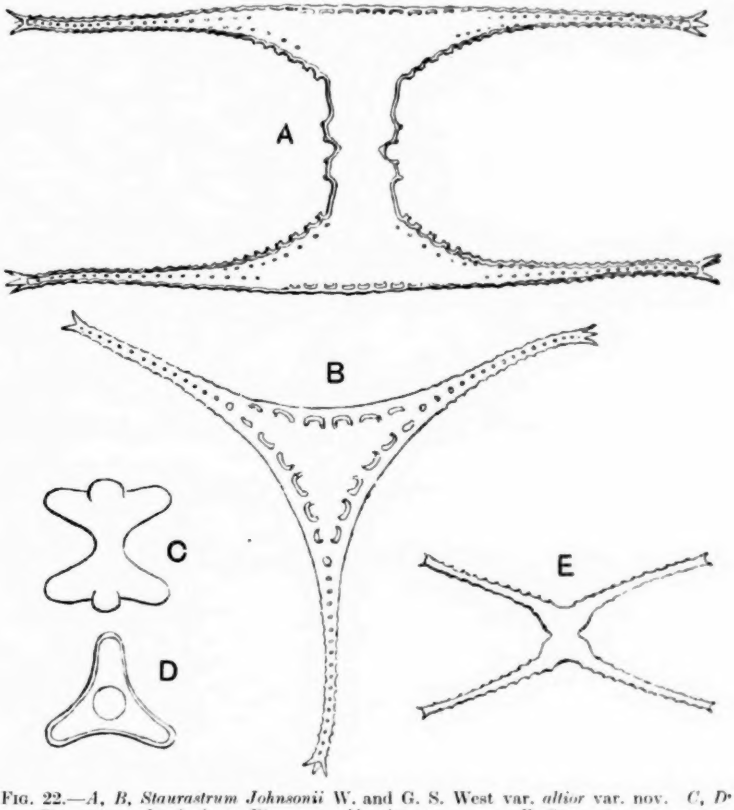

FIG. 22.—*A, B, Staurastrum Johnsonii* W. and G. S. West var. *altior* var. nov. *C, D*, *Staurastrum laevispinum* Biss. var. *abbreviata* var. nov. *E, Staurastrum excavatum* West, forma. (*A–D*, × 750; *E*, × 800.)

it was spherical, and furnished with rather long spines. The zygospore of the type is as yet unknown.

Staurastrum leptocladum Nordst. var. *cornutum* Wille, *forma* brachiis fere horizontalibus.

Long. cell., 37–44 μ; lat. sine proc., 10 μ; cum proc., 100–120 μ; isthm., 6–8 μ; crass., 15 μ (72, 75). (Fig. 23, *A* and *a*.)

The individuals of this form are a little larger than those recorded by

the Wests from Madagascar, but agree closely with those originally described by Wille. The long arms end in two divergent teeth, and are not markedly upturned as is commonly the case in this variety.

Already recorded for the Transvaal.

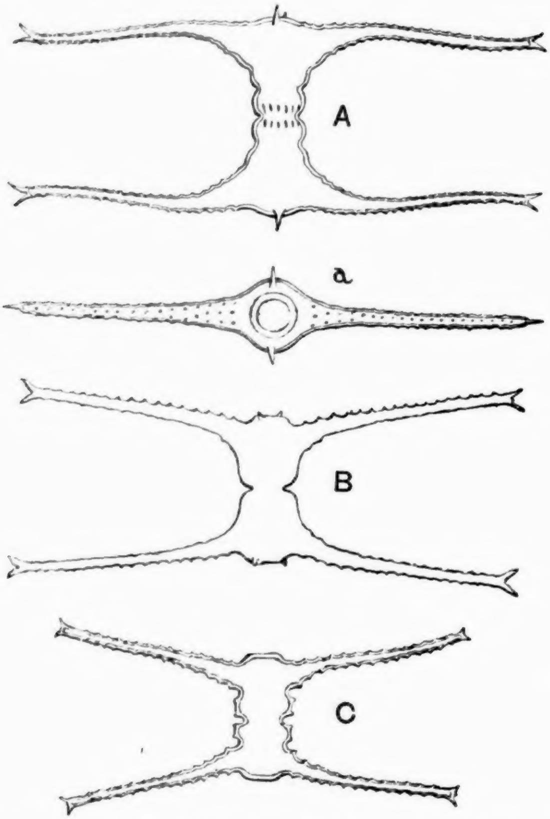

FIG. 23.—*A*, *a*, *Staurastrum leptocladum* Nordst. var. *cornutum* Wille, forma. *B*, *Staurastrum leptocladum* Nordst. var. *simplex* var. nov. *C*, *Staurastrum longiradiatum* West var. *elevatum* var. nov. (All × 750.)

Var. *simplex* var. nov. (Fig. 23, *B*).

Differt a typo cellulis brevioribus, apice in media parte elevato subdeplanato, membrana semicellulae supra isthmum laevi, parte basali semicellulae latiore. Long. cell., 25–29 μ; lat. cum proc., 80–110 μ; isthm., 10 μ; crass., 14 μ (75, 1134, 1136 *b* and *c*; common in 1136 *c*).

The body of the cell is more like that of var. *cornutum* Wille than that of the type as figured by Nordstedt (1887, fig. 57), since it is proportionately broader and shorter; moreover, it is devoid of the characteristic markings above the isthmus which are found both in the type and in var. *cornutum*. The biradiate end-view closely resembles that of the form above described, but in front-view the long arms are seen to be not so gracefully curved. The teeth on the upper margin of the processes are more markedly developed than on the lower. The apex of the semicell is distinctly elevated and flattened, with two short subapical spines inserted one on each side, as in var. *cornutum*.

In the shape of the apex there is a resemblance to *S. americanum* (W. and G. S. West) G. M. Smith.

Staurastrum longiradiatum W. and G. S. West.

Var. *elevatum* var. nov. (Fig. 23, *C*).

Differt a typo brachiis longioribus, horizontalibus vel leviter divergentibus, apice semicellulae elevato deplanato vel truncato. Long. cell., 24–28 μ; lat., 76–93 μ; isthm., 7–8 μ (72, 75). This variety resembles var. *subnudum* G. S. West (1909, p. 73, Pl. VI, fig. 23) in the features presented by the basal parts of the semicells, but the processes are proportionately longer, and the apex of the semicell distinctly elevated, the raised portion being flattened and almost truncate. The end-view is biradiate.

Staurastrum muticum Bréb. forma *minor* Rabenh. (*S. muticum* var. *depressum* Nordst.). (Fig. 24, *A*, *B*.)

Long. cell., 19–21 μ; lat., 24–30 μ; isthm., 4–5 μ (6 *b*, 75).

The form here figured has more markedly depressed semicells than any that have hitherto been recorded. Note the proportion of width to length.

Staurastrum paradoxum Meyen var. *evolutum* W. and G. S. West; West and Carter, 1923, p. 107, Pl. CXLV, figs. 7, 8. (Syn.: *S. tetracerum* (Kütz.) Ralfs var. *evolutum* W. and G. S. West.)

Long. cell., 10 μ; lat. cum proc., 32–35 μ; sine proc., circa 8 μ; isthm., 4–5 μ (6 *b*, 7, 72, 75, 1134, 1136 *b*).

The individuals agreed in dimensions with those found by the Wests in the Orkneys. The cells were usually twisted so that the processes of one semicell alternated with those of the other. In end-view the long slender arms were often curved.

Var. *parvum* West; West and Carter, 1923, p. 106, Pl. CXLV, fig. 6.

Long. cell., 13 μ; lat. cum proc., 28 μ; isthm., 5–6 μ (1134).

There were also present a number of forms intermediate between this variety and the type.

Staurastrum pterosporum Lund.; West and Carter, 1923, p. 14, Pl. CXXXII, fig. 1.

Long. cell., 11–12 μ; lat. sine spin., 12–16 μ; isthm., 5 μ; spin., circa 5 μ (1136 *a*).

Staurastrum rectangulare Borge.

Forma *minor*. Long. cell. sine proc., 17–18 μ; lat. cum proc., 20–24 μ; isthm., 4–5 μ (6 *b*, 7, 72, 75). (Fig. 24, *H*, *I*.)

This differs from Borge's form essentially in its smaller dimensions,

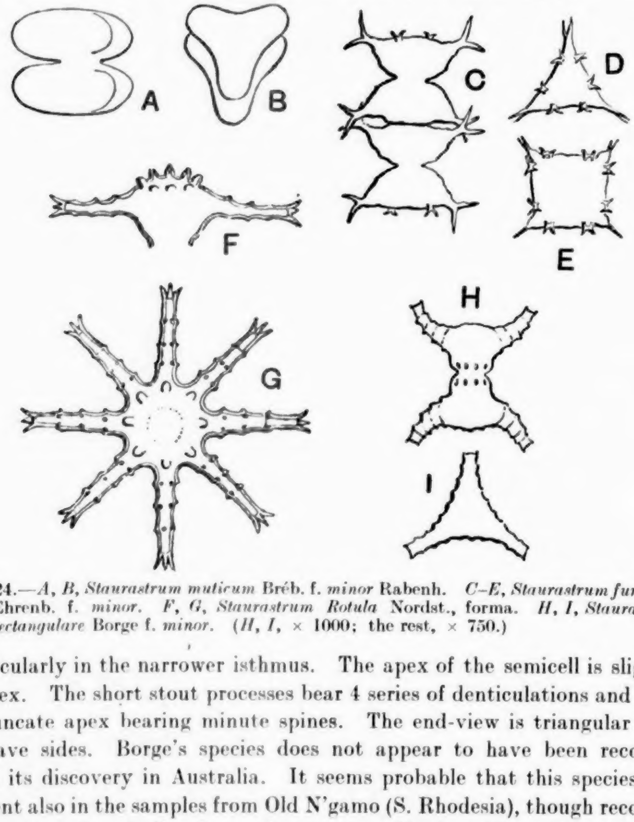

Fig. 24.—*A*, *B*, *Staurastrum muticum* Bréb. f. *minor* Rabenh. *C–E*, *Staurastrum furcatum* Ehrenb. f. *minor*. *F*, *G*, *Staurastrum Rotula* Nordst., forma. *H*, *I*, *Staurastrum rectangulare* Borge f. *minor*. (*H*, *I*, × 1000; the rest, × 750.)

particularly in the narrower isthmus. The apex of the semicell is slightly convex. The short stout processes bear 4 series of denticulations and have a truncate apex bearing minute spines. The end-view is triangular with concave sides. Borge's species does not appear to have been recorded since its discovery in Australia. It seems probable that this species was present also in the samples from Old N'gamo (S. Rhodesia), though recorded under the rather similar *S. pseudotetracerum* (Nordst.) W. and G. S. West.

Staurastrum Rotula Nordst., 1887, Pl. IV, fig. 38.

Forma paullo minor, granulis apicalibus majoribus. Long. cell., 33 μ; lat. cum proc., 57–73 μ; isthm., 8 μ (1134, 1136 *a–c*). (Fig. 24, *F*, *G*.)

The rather small individuals were from seven- to nine- (usually eight-) radiate in end-view, the processes being generally provided with 3 (sometimes 4) series of teeth, and terminating in 3 spines. The apical granules were larger than in the type and obtusely conical in shape (cf. Taylor, 1935, Pl. XXXVII, fig. 8).

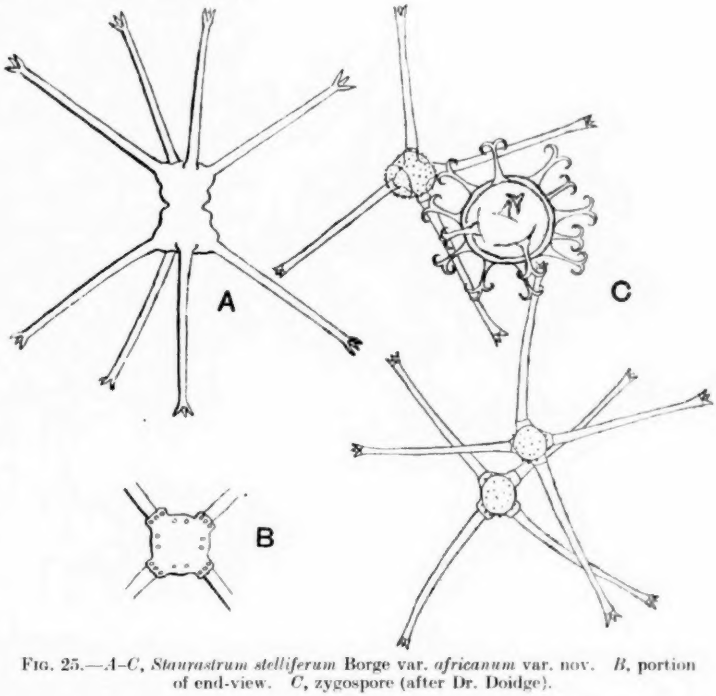

FIG. 25.—*A–C*, *Staurastrum stelliferum* Borge var. *africanum* var. nov. *B*, portion of end-view. *C*, zygospore (after Dr. Doidge).

S. Rotula bears a close resemblance to *S. sagittarium* Nordst. (recorded from New Zealand), but differs from it in having fewer denticulations on the arms, and in the presence of the ring of conical papillae near the apex of the semicell. The form here recorded also resembles *S. acanthastrum* W. and G. S. West, recorded from Ceylon, in which, however, the body of the semicell is proportionately smaller. It may be doubted whether *S. acanthastrum* should be regarded as more than a variety of *S. Rotula*.

Staurastrum stelliferum Borge, 1925, p. 42, Tab. VI, fig. 3.

Var. *africanum* var. nov. (Fig. 25).

Differt a typo brachiis 4 longioribus apice tridenticulato, marginibus lateralibus corporis semicellulae in aspectu frontali undulatis, granulis in

parte apicali semicellulae a vertice visae symmetrice dispositis. Zygosporae globosae, spinis elongatis in apicem cum dentibus recurvatis 2 vel 3 praeditis. Long. sine proc., 27–37 μ; cum proc., 108–150 μ; lat. sine proc., 16–19 μ; cum proc., 94–108 μ; isthm., 13–14 μ; diam. zygosp. sine proc., circa 35 μ (6 *b*, 7, 72, 75).

The four arms of each semicell appear in the front-view as a pair arising from the apical angles of the semicell, while one arm arises within the apex

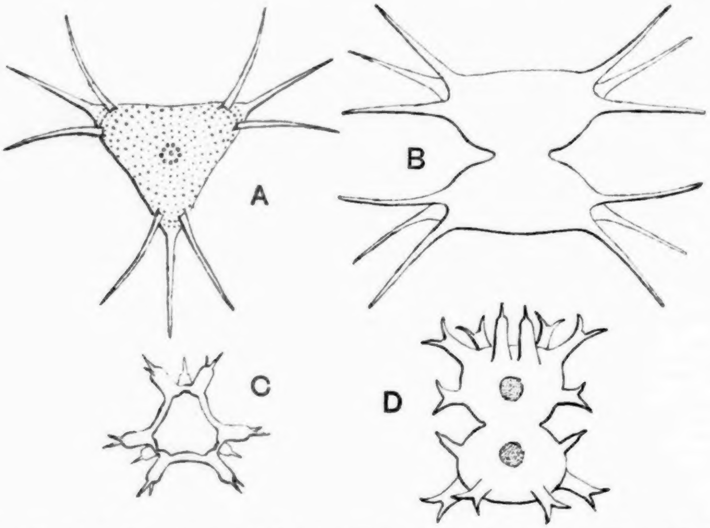

Fig. 26.—*A*, *B*, *Staurastrum subtrifurcatum* W. and G. S. West var. *major* W. and G. S. West, forma, (× 400). *C*, *D*, *Staurastrum Tohopekaligense* Wolle var. *trifurcatum* W. and G. S. West, forma *minor* (× 1000).

from each face of the semicell. The smooth arms are longer than in the type, and terminate in 3 slightly curved teeth. In end-view the quadrate body of the semicell shows 3 granules at the base of each arm, and 2, more widely spaced, in the part in between each pair of arms; the angles are flattened and form enlarged bases to the arms. A characteristic feature is the undulation of the lateral margins of the semicells above the isthmus.

S. stelliferum has hitherto been recorded only from S. America and the zygospore has not previously been described. That of the variety here recorded is spherical, and bears symmetrically disposed spines, about half as long as the diameter of the spore, with 2 or 3 recurved teeth at the apex.

A form resembling forma *tetragona* Borge (loc. cit., Pl. VI, fig. 4), in

which 2 or 3 pointed teeth are present at the bases of the arms, was observed in Sample 1136 *b*. Here too the arms were longer than in the specimens described by Borge.

Staurastrum subtrifurcatum W. and G. S. West, 1896, p. 258, Pl. XVI, fig. 24, var. *major* W. and G. S. West, 1907, p. 214 (Syn.: *S. subtrifurcatum* Schmidle).

Forma granulis majoribus in parte centrali in aspectu verticali. Long. sine spin., 80 μ; lat. sine spin., 60–70 μ; isthm., 29–30 μ; long. spin., circa 40 μ (72, 1136 *b* and *c*). (Fig. 26, *A*, *B*.)

Krieger (1932, p. 208, Pl. XIX, fig. 1) has already recorded a punctate membrane in this variety, but the Transvaal form is distinguished by the series of larger granules in the middle of the apex in end-view.

S. Wildemani Gutwinski (1902, p. 605, Pl. XL, fig. 61) is closely allied to *S. subtrifurcatum*, differing chiefly from it in the fact that the angles of the semicells bear, in the former, only two spines. Schmidle (1902, p. 73, Tab. II, fig. 9) has recorded from Lake Nyasa a forma *bidens* of *S. subtrifurcatum* which resembles very closely the figure of *S. Wildemani* given by Krieger (1932, Pl. XIX, fig. 2), except that in the latter slightly larger granules are indicated in the middle of the apex in end-view (cf. also Krieger's figure of *S. subtrifurcatum* var. *major*). It may be doubted whether the number of spines is a suitable criterion for distinguishing species, since this character is known to be variable in *Staurastrum*. *S. Wildemani* should probably be regarded as synonymous with *S. subtrifurcatum* f. *bidens* Schmidle. The form with two spines was recorded from Old N'gamo under *S. Wildemani*.

Staurastrum subunguiferum sp. nov. (Fig. 27, *F–J*).

S. ca. duplo longior quam latum, modice constrictum, sinu obtuso aperto; semicellulis a fronte visis subcircularibus, marginibus lateralibus et apicibus convexis, brachiis adscendentibus 3 cum spina brevi acuta terminali, membrana cum serie transversali granulorum 2 in media parte semicellulae; semicellulis a vertice visis circularibus, processibus 3 symmetrice dispositis, cum granulo centrali et circulo granulorum 9–10 et aliis granulis in series radiantes 2 inter processus. Long. cell. (sine proc.), 40–44 μ; lat., 24–28 μ; isthm., 13–17 μ; long. proc. max., 18 μ (1134, 1136 *a–c*).

The disposition of the granules in end-view is striking, but the exact relation between their arrangement in front- and end-views has not been deciphered. The chloroplasts appear to be axile.

In front-view this species shows a very marked resemblance to *S. unguiferum* Turner (1892, p. 130), though the apical processes are rather different. In the circular end-view the species differs very markedly from any other known *Staurastrum*, and in this respect approaches the genus *Ichthyocercus* (W. and G. S. West, 1897, p. 21).

Staurastrum Tohopekaligense Wolle var. *trifurcatum* W. and G. S. West: West and Carter, 1923, p. 179, Pl. CLV, fig. 13 *a*.

Forma *minor*. Long. sine proc., 17–24 μ; cum proc., 24–37 μ; lat. sine proc., 13–18 μ; cum proc., 24–30 μ; isthm., 8–9 μ (72). (Fig. 26, *C*, *D*.)

The end-view shows 6 processes arranged in pairs at the angles, and three further processes arising at a lower level and inserted between those of each pair. In front-view the paired apical processes are likewise recognisable, while the lateral margins, a little way above the isthmus, bear an additional process, often directed towards the isthmus. The processes vary in the number of apical teeth; most usually there are 2, while the lateral processes occasionally have 3 teeth. Carter (loc. cit., p. 179) has already commented on the variability of this feature. The specimens found in the Belfast Pan are appreciably smaller than those recorded from other regions. *S. Tohopekaligense* appears to be widely distributed in S. Africa.

Staurastrum unguiferum Turner, 1892, p. 130, Tab. XV, fig. 18.

Var. *corniculatum* var. nov. (Fig. 27, *A*, *B*).

Differt a typo processibus longioribus gracilioribus.

Long. cell., 30–34 μ; lat., 19 μ; isthm., 13–27 μ (7).

The general appearance of the front-view is quite as in the type, but the upwardly directed processes are appreciably longer, and, in proportion to their length, more slender; the terminal spines are not so distinctly set off from the rest of the process as in the type.

Staurastrum vestitum Ralfs.

Forma *minor*. Long. cell., 26–28 μ; lat. cum proc., 30–52 μ; isthm., 4–7 μ (6 *b*, 72, 75). (Fig. 27, *E*.)

Since no good specimens showing the individuals in front-view were obtained, this reference is based mainly on the end-view. The latter shows the two emarginate warts projecting from the middle part of each margin which is characteristic of *S. vestitum*; a smaller wart was evident on either side of each pair.

Staurastrum Zahlbruckneri Lütkemüller, 1900, p. 125, figs. 41–43.

Var. *africanum* var. nov. (Fig. 27, *C*, *D*).

Differt a typo magnitudine multe minore, semicellulis plus minus depressis ellipticis, marginibus lateralibus semicellulae in aspectu frontali basin versus crenulatis; semicellulis a vertice visis lateribus leviter concavis, angulis 2–3-crenatis; membrana glabra vel punctata.

Long. cell., 42–48 μ; lat., 39–45 μ; isthm., 12–15 μ (6 *b*, 7, 72, 75).

This variety is distinguished by its much smaller dimensions which are less than half those of the type, by the often depressed semicells which have slightly concave margins in end-view, and by the crenation of the lateral margins in the basal parts of the semicells in front-view. The basal angles

of the semicells show a stronger thickening of the membrane, which is also evident in the end-view. The angles in the end-view are crenulate, and the edges of the down-curved processes of the semicells are seen, in the front-

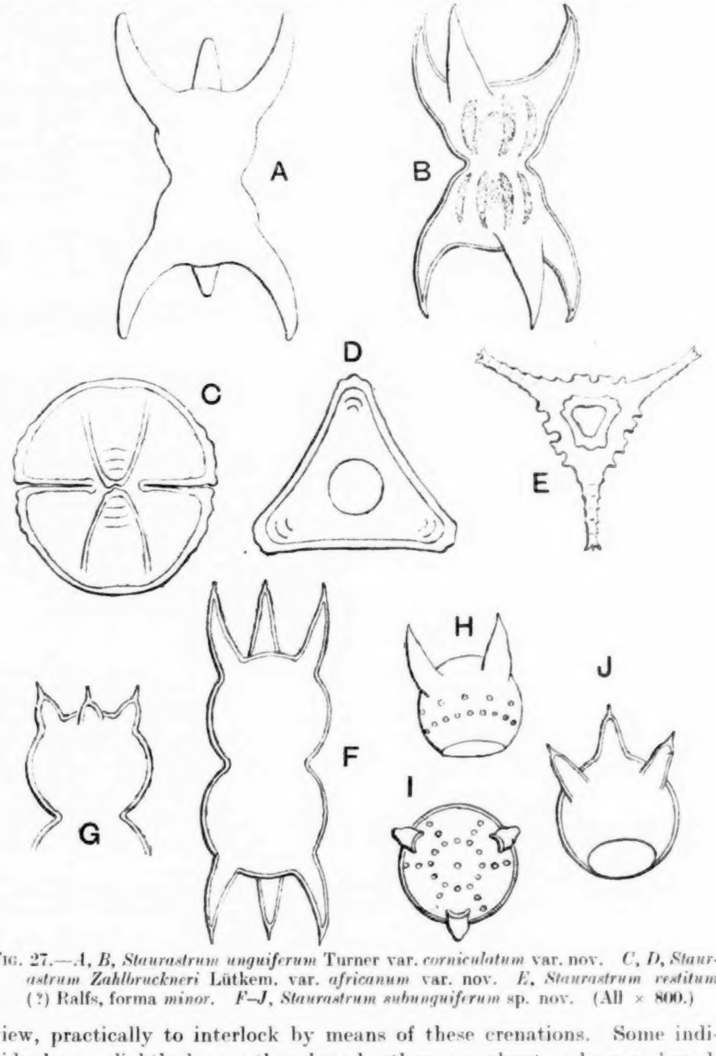

FIG. 27.—*A, B, Staurastrum unguiferum* Turner var. *corniculatum* var. nov. *C, D, Staurastrum Zahlbruckneri* Lütkem. var. *africanum* var. nov. *E, Staurastrum vestitum* (?) Ralfs, forma *minor*. *F–J, Staurastrum subunguiferum* sp. nov. (All × 800.)

view, practically to interlock by means of these crenations. Some individuals are slightly longer than broad, others are about as long as broad. The membrane may be smooth or punctate.

Genus ONYCHONEMA Wallich.

Onychonema filiforme (Ehr.) Roy et Biss.: West and Carter, 1923, p. 216, Pl. CLX, fig. 14.

Long. cell., 11–12 μ; lat., 10–13 μ; isthm., 3·5 μ (7, 72).

Onychonema laeve Nordstedt, 1887, p. 206, fig. 34.

Forma. Long. cell., 16 μ; lat. sine spin., 18 μ; isthm., 5 μ (72, rare).

The form present differs from the type as described and figured by Nordstedt (loc. cit.) in the lesser width and in the shorter spines which are not markedly convergent. The spines are slightly shorter than the apical processes.

Genus SPHAEROZOSMA Corda.

Sphaerozosma excavatum Ralfs: West and Carter, 1923, p. 211, Pl. CLX, figs. 2–3.

Long. cell., 9–11 μ; lat., 8–11 μ; isthm., 4·5 μ; crass., 5 μ; lat. zygospor., 12–15 μ (7, 75).

The zygospore is more or less spherical, with a smooth wall.

Recorded from Central Africa.

Genus SPONDYLOSIUM de Brébisson.

Spondylosium tetragonum West, 1892, p. 115, Tab. XIX, fig. 2.

Long. cell., 9–11 μ; lat., 6–7·5 μ; isthm., 4–4·5 μ (7, 72, 75).

Genus PHYMATODOCIS Nordstedt.

Phymatodocis irregulare Schmidle, 1899, p. 13. (Fig. nostr. 28, *A*, *B*.)

Long. cell., 26–29 μ; lat., 48–50 μ (7, 72, 75, 1136 *c*).

The dimensions agree with those of individuals found by Messrs. West (1902, p. 175) in Ceylon.

Not previously recorded for S. Africa.

Genus HYALOTHECA Ehrenberg.

Hyalotheca mucosa (Mert.) Ehr. var. *minor* Roy et Biss.; West and Carter, 1923, p. 236, Pl. CLXII, fig. 5.

Long. cell., 14 μ; lat., 10 μ (72, 75).

Zygospores were observed in one sample.

The type has been recorded from Tanganyika and the Transvaal.

Genus DESMIDIUM Agardh.

Desmidium coarctatum Nordst. var. *cambricum* West; West and Carter, 1923, p. 252. (Fig. nostr. 29, *C*.)

Long. cell., 21–25 μ; lat., 35–37 μ (7, 1134).

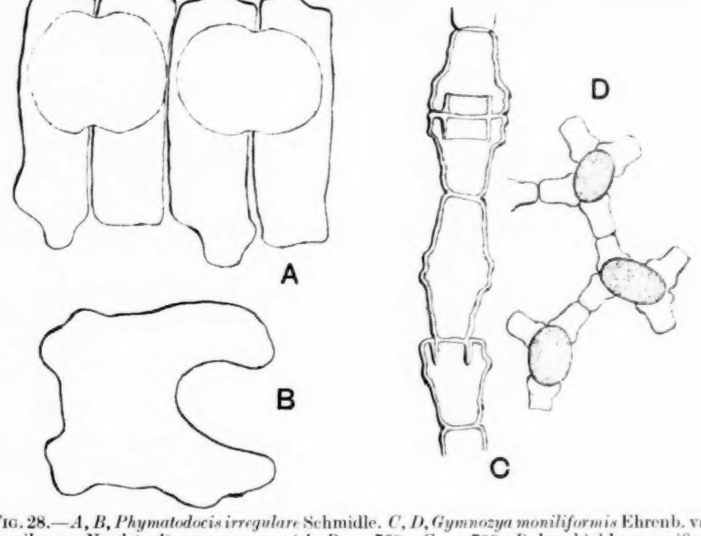

FIG. 28.—*A*, *B*, *Phymatodocis irregulare* Schmidle. *C*, *D*, *Gymnozyga moniliformis* Ehrenb. var. *gracilescens* Nordst; *D*, zygospores. (*A*, *B*, × 750; *C*, × 700; *D*, less highly magnified.)

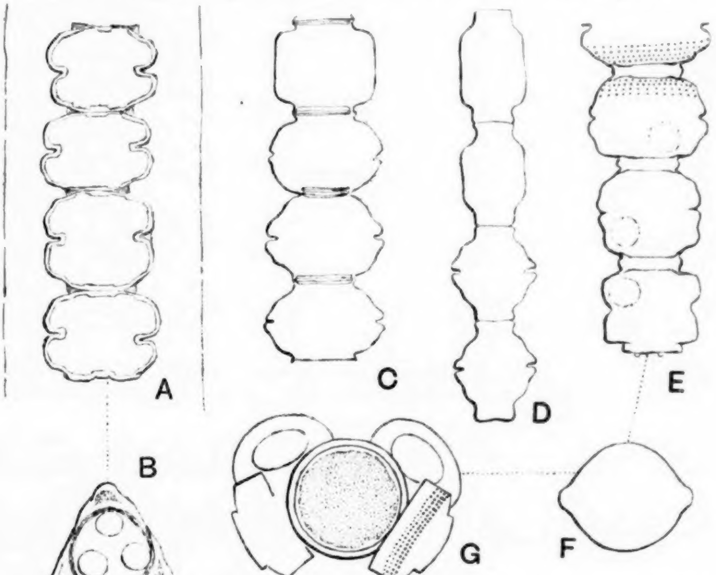

FIG. 29.—*A*, *B*, *Desmidium occidentale* W. and G. S. West. *B*, end-view. *C*, *Desmidium coarctatum* Nordst. var. *cambricum* West. *D*, *Desmidium graciliceps* (Nordst.) Lagerh., forma. *E–G*, *Desmidium quadratum* Nordst., forma *punctata* f. n.: *F*, end-view; *G*, zygospore. (*A–C*, × 500; *D*, × 570; *E–G*, × 650.)

The apex of the semicell is equal to about half the diameter of the widest portion of the cell.

Desmidium graciliceps (Nordst.) Lagerh.; West and Carter, 1923, p. 253.

Forma. Long. cell., 29–30 μ; lat., 21 μ; isthm., 16 μ; lat. apic., 9–10 μ (75). (Fig. 29, *D.*)

The cells are rather longer and narrower than in the type.

Desmidium occidentale W. and G. S. West, 1923, p. 245. (Fig. nostr. 29, *A, B.*)

Long. cell., 24–26 μ; lat., 30–35 μ (1134, 1136 *b*, 1137).

Rather common amongst *Utricularia* and Cyperaceae.

Desmidium quadratum Nordst.

Forma *punctata* f. n. Semicellulis cum seriebus punctorum circa 4 horizontalibus munitis. Long. cell., 21–24 μ; lat., 33–36 μ; crass., 21–22 μ; diam. zygospor., 30 μ (7, 72, 1134, 1136 *b*). (Fig. 29, *E–G.*)

Each semicell is furnished with about 4 horizontal rows of puncta. Such puncta are not mentioned by Carter and West in their description of the species, although a single row of puncta is indicated in the original figure of Nordstedt. The successive cells are connected by thick intercellular pads. The zygospore has a smooth thick membrane.

Genus Gymnozyga Ehrenberg.

Gymnozyga moniliformis Ehrenb. var. *gracilescens* Nordst. (Fig. nostr. 28, *C, D.*)

Long. cell., 30–36 μ; lat., 14–15 μ; zygospor., 22 × 15 μ. (Rather common in 72, 75.)

CLASS II. XANTHOPHYCEAE (HETEROKONTAE).

Genus Botryococcus Kützing.

Botryococcus Braunii Kütz.

Lat. cell., 7–9 μ (6 *b*, 7, 75).

This alga is very widely distributed in S. Africa.

It is possible that *B. sudeticus* Lemm. was also present in 6 *b*.

Genus Stichogloea Chodat.

Stichogloea olivacea Chodat. (Fig. 30, *A.*)

Cells (10 μ × 6 μ) in fours connected by wide mucilage-stalks (75).

Genus Ophiocytium Naegeli.

Ophiocytium capitatum Wolle; Pascher, 1925, p. 78, fig. 62 *a*.

Lat. cell., 7–11 μ. Spines variable in length, usually about 10 μ, but reaching 18 μ (6 *b*, 7, 72, 75, 1136 *b, c*).

Ophiocytium cochleare A. Br.

Lat. cell., 8–9 μ; long. spin., circa 20 μ (6 *b*, 72, 1136 *b*, *c*).

The dimensions agree with those given by Messrs. West (1907) for specimens from Burmah.

CLASS III. CHRYSOPHYCEAE.

Genus Dinobryon Ehrenberg.

Dinobryon sertularia Ehrenb.; Pascher, 1913, p. 72, fig. 112.

Long. cell., circa 30 μ; lat. apert., circa 9–10 μ; lat. coll., circa 7 μ. (Rare in 6 *b*, 75, 1134.)

CLASS IV. BACILLARIOPHYCEAE.

Genus Pinnularia Ehrenberg.

Pinnularia borealis Ehrb.

Long., 40 μ; lat., 10 μ; striae in 10 μ = 4–5. (Very rare in 6 *b*.)

Previously recorded from the Transvaal (Ermelo).

Pinnularia dactylus Ehrb.

Long., 240 μ; lat., 36 μ; striae in 10 μ = 5. (Rare in 1136 *c*.)

Recorded for Portuguese East Africa.

Pinnularia major (Kütz.) Cleve, forma *hyalina* Hust.

Long., 120–140 μ; lat., 24–28 μ; striae in 10 μ = 7 (6 *b*, 1134).

There is a slight median enlargement; the axial area is wider than in the type.

Var. *linearis* Cleve.

Long., 180–210 μ; lat., 24–30 μ; striae in 10 μ = 7 (6 *b*).

Recorded for Ermelo.

Pinnularia microstauron (Ehrb.) Cleve var. *Brebissonii* (Kütz.) Hust. (Syn.: *P. Brebissonii* Kütz.).

Forma *linearis* O. Müll. Long., 60–84 μ; lat., 12–16 μ; striae in 10 μ = 9–11 (6 *b*, 75, 1136 *a*).

The gap in the striae is sometimes on both sides, sometimes on one side only.

P. Brebissonii was recorded for Griqualand West.

Genus Cymbella Agardh.

Cymbella laevis Naeg.

Long., 26–30 μ; lat., 7–8 μ; striae in 10 μ = circa 12 (6 *b*).

Genus EUNOTIA Ehrenberg.

Eunotia monodon Ehrb.

Long., 72 μ; lat., 12 μ (6 *b*).

Eunotia pectinalis (Kütz.) Rabh. var. *minor* (Kütz.) Rabh.

Forma *impressa* (Ehrb.) Hust.

Long., 37–44 μ; lat., 6 μ (6 *b*, 75).

Genus SURIRELLA Turpin.

Surirella ovalis Bréb.

Long., 74 μ; lat., 42 μ. Costae in 10 μ = 4–5 (7).

Recorded for S. Africa.

CLASS VI. DINOPHYCEAE (PERIDINIEAE).

Species of *Peridinium* were present in most of the samples, but the material was not adequate for satisfactory determination. *P. tabulatum* (Ehrb.) Clap. et Lachm. was certainly present, while *P. Cunningtonii* Lemm. and *P. inconspicuum* Lemm. were probably represented.

CLASS VIII. EUGLENINEAE.

Genus EUGLENA Ehrenberg.

Euglena intermedia (Klebs) Schmitz var. *brevis* Fritsch and Rich, 1929, p. 71, fig. 25, *G*.

Long., 64 μ; lat., 8 μ (6 *b*).

Recorded from Griqualand West.

Other species of *Euglena* present were represented only by rare individuals.

Genus PHACUS Dujardin.

Phacus orbicularis Hubner var. *minor* Fritsch and Rich, 1929, p. 77, fig. 25, *I*.

Long., 33 μ; lat., 26 μ. (Rare in 6 *b*.)

Similar to the form found in Griqualand West, but without the lateral notches.

Phacus pyrum (Ehrb.) Stein.

Long., 34 μ; lat., 15 μ. (Very rare in 6 *b*.)

Recorded from Griqualand West.

Genus TRACHELOMONAS Ehrenberg.

Trachelomonas bernardinensis Vischer, Bull. Soc. Bot. Genève, VII, 1915, p. 197, fig. III.

Forma? Long. integ., 50–54 μ; lat., 20–21 μ; long. coll., 6 μ (6 *b*). (Fig. 30, *D*.)

In outward form the individuals are like those figured by Vischer, but the neck is longer, and the envelope practically colourless. The envelope

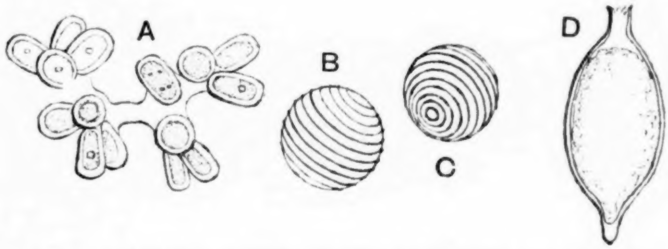

FIG. 30.—*A*, *Stichogloea olivacea* Chod. *B*, *C*, *Trachelomonas rugulosa* Stein, forma. *D*, *Trachelomonas bernardinensis* Vischer.

is punctate, and very strongly thickened at the posterior end where the short spine arises.

Trachelomonas hispida (Perty) Stein.

Rare in 1136 *c*.

Frequently recorded for S. Africa.

Trachelomonas rugulosa Stein (= *T. stokesiana* Palmer), forma. (Fig. 30, *B*, *C*.)

Diameter, 18–20 μ (1134, 1136 *b*).

The individuals present did not show anastomosis of the ribs, such as is usually shown in the figures of *T. rugulosa*.

Previously recorded for the Transvaal.

Trachelomonas volvocina Ehrenb.

6 *b*, 1136 *b*.

Previously recorded for Griqualand West, the Cape, and the Transvaal.

CLASS XI. MYXOPHYCEAE (CYANOPHYCEAE).

Genus APHANOCAPSA Naegeli.

Aphanocapsa elachista W. and G. S. West var. *conferta* W. and G. S. West.

Lat. cell., 2 μ (6 *b*, 1134).

Genus Aphanothece Naegeli.

Aphanothece microscopica Naeg.: Geitler, 1932, p. 172.
Lat. cell., 4 μ, 1½ plo. long. quam lat. (1136 *c*).
Common in Africa.

Aphanothece nidulans P. Richt.; Geitler, 1932, p. 168, fig. 75 *c*.
Lat. cell., circa 1·5 μ; long., 3·5 μ. (Rather rare in 1136 *c*.)

Genus Gloeocapsa Kützing.

Gloeocapsa rupestris Kütz.
7, rare.
Recorded for Angola and Natal.

Genus Chroococcus Naegeli.

Chroococcus limneticus Lemm.
Diam. cell., 12–14 μ (6 *b*).
Recorded from Victoria Nyanza.

Chroococcus minor (Kütz.) Naeg.
Diam. cell., 3–4 μ (1136).
In clusters consisting of about 4 groups of 4 cells.
Recorded from Tanganyika, Madagascar, and the Cape.

Genus Merismopedia Meyen.

Merismopedia glauca (Ehrenb.) Naeg.
Lat. cell., circa 4 μ. (Rare in 6 *b*.)
Recorded from Griqualand West.

Genus Stigonema Agardh.

Stigonema informe Kütz.
Lat. fil., 18–50 μ; lat. cell., 7–14 μ. (Tangled amongst *Nitella* in 7, 72, 1134, 1136 *a*, *b*, *c*.)
The material was very fragmentary, and we make the determination with some hesitation.
Recorded for Angola and Natal.

Stigonema (? *ocellatum* Thuret).
Filaments, 30–33 μ wide; cells, 8–11 μ wide (1134).

Genus Hapalosiphon Naegeli.

Hapalosiphon fontinalis (Ag.) Born.: Frémy, 1930, fig. 342. (Fig. nostr. 31, *C.*)

Main filament, 10–14 μ wide; branches, 6–10 μ wide. The material formed soft lumps intermingled with other algae and with *Nitella*.

The sheath is colourless, not very wide, with a thickened margin. The branches are rare and usually stand singly. The heterocysts are elongate-cylindrical in shape. The form present is distinguished by the scanty branching, the fragment figured being rather exceptional in this respect.

H. fontinalis is cosmopolitan; it has previously been recorded from S. Rhodesia.

Genus Calothrix Agardh.

Calothrix fusca Born. and Flah.

7.

Recorded from S. Rhodesia and other parts of S. Africa.

Genus Gloeotrichia Agardh.

Gloeotrichia Pisum Thuret.

7.

Recorded from S. Rhodesia.

Genus Scytonema Agardh.

Scytonema sp. (Fig. 31, *A*, *B*.)

Lat. fil., 20–24 μ; lat. trich., 4–10 μ; long. heterocyst., 12–28 μ.

(Amongst other algae and *Utricularia* in 1134, 1136 *a*, *b*.) The usually paired false branches occur only at long intervals, and narrow slightly at their point of origin from the main filament. The thick sheath, which is sometimes constricted at intervals, shows no stratification, and is colourless save for a thin inner layer which is yellow or brown in colour. The cells of the trichomes are 2–3 times as long as wide, with elongate-cylindrical heterocysts of the same width.

This form resembles *S. polymorphum* Naeg. as figured and described by Möbius (1888, p. 245). It is, however, doubtful whether Möbius's form belongs to the species of Naegeli, which is not included in Geitler's recent synopsis. It is impossible to refer with certainty the form above described to any known species, but, in view of the scanty material and the numerous ill-defined species of *Scytonema* already published, we have preferred not to add to their number by placing it in a new species.

Genus CYLINDROSPERMUM Kützing.

Cylindrospermum sp. (? *minutissimum* Collins). (Fig. nostr. 31, *D, E.*)

Lat. cell., 3 μ, $1\frac{1}{2}$–$2\frac{1}{2}$ plo long. quam lat.; lat. heterocyst., 3 μ, long., 4–6 μ (1134, 1136 *a, b*).

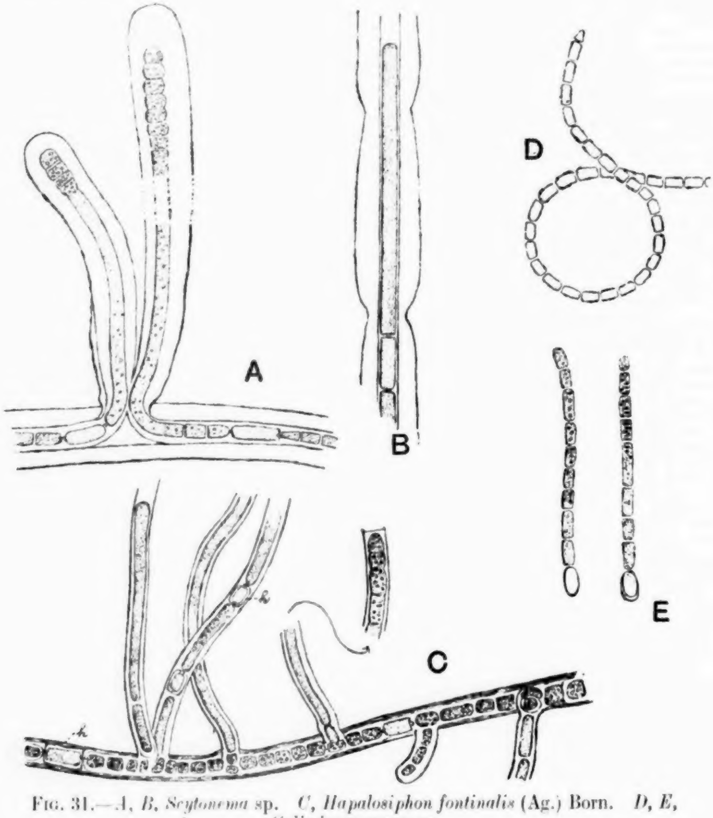

FIG. 31.—*A, B, Scytonema* sp. *C, Hapalosiphon fontinalis* (Ag.) Born. *D, E, Cylindrospermum* sp.

The rather short filaments formed a loosely entangled mass. The end cell is conical, the heterocysts elliptical. No spores were observed.

Genus OSCILLATORIA Vaucher.

Oscillatoria splendida Grev.: Geitler, 1932, fig. 620 *e*.

Lat. trich., 2 μ (1136 *a*).

The trichomes are attenuated at the apices, which are curved, and terminate in a slight enlargement.

Recorded already from the Transvaal.

Genus PHORMIDIUM Kützing.

Phormidium autumnale (Ag.) Gom.

6 *b*.

Widely distributed in Africa.

Phormidium tenue (Menegh.) Gomont, 1893, Pl. IV, fig. 24.

Cells 1 μ wide (1136).

Common in S. Africa.

Genus LYNGBYA Agardh.

Lyngbya perelegans Lemm.; Frémy, 1930, fig. 166 (1136 *b*).

Recorded from Tanganyika.

Genus SCHIZOTHRIX Kützing.

Schizothrix sp.

Lat. fil., 2·5–3 μ; lat. trich., circa 1 μ (1136 *a*, *b*).

Material inadequate for determination.

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ARCHAEOLOGY OF THE OAKHURST SHELTER, GEORGE.

(Publication of the School of African Studies.)

Part I. Course of the Excavation.

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(With two Text-figures.)

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The farm Oakhurst lies some 13 miles east of the town of George, between the George-Knysna Road and the coastal lakes. The owner, Mr. R. E. Dumbleton, who has had considerable experience as an excavator (see Péringuey, "The Stone Ages of South Africa," Ann. S.A. Mus., vol. viii, pp. 149–152), reported the finding of a rock-shelter in an enclosed valley on the farm, containing undisturbed deposits of unknown depth. Dr. E. L. Gill of the South African Museum kindly invited me to undertake the investigation. This action on the part of Mr. Dumbleton has led to six visits to the cave, varying in length from a month to a week, and his extreme generosity as a host has enabled investigation to continue through a period when financial aid was not obtainable.

Surroundings.

The shelter is situated about 2 miles from the lakes which border the sea, and about 4 miles from the ocean. It is in virgin forest, and stands about 20 feet above the Klein Keurbooms stream (see fig. 1). It faces east, and is slightly cut into the southern corner of a high overhanging kranz or cliff of a schistose quartz-bearing sandstone, identified by Dr. S. H. Haughton as a Table Mountain sandstone rendered schistose by excessive folding. The shelter is approached by an old elephant path leading down, from the 300-foot peneplain above, through dense forest. Access from the shelter to the sea is rendered difficult, as the stream passes through a narrow gate of overhanging rock about 50 yards downstream from the cave. The gate is cut through the same cliffs, which here overhang the river, and allow access to the 20-foot peneplain only through a pool.

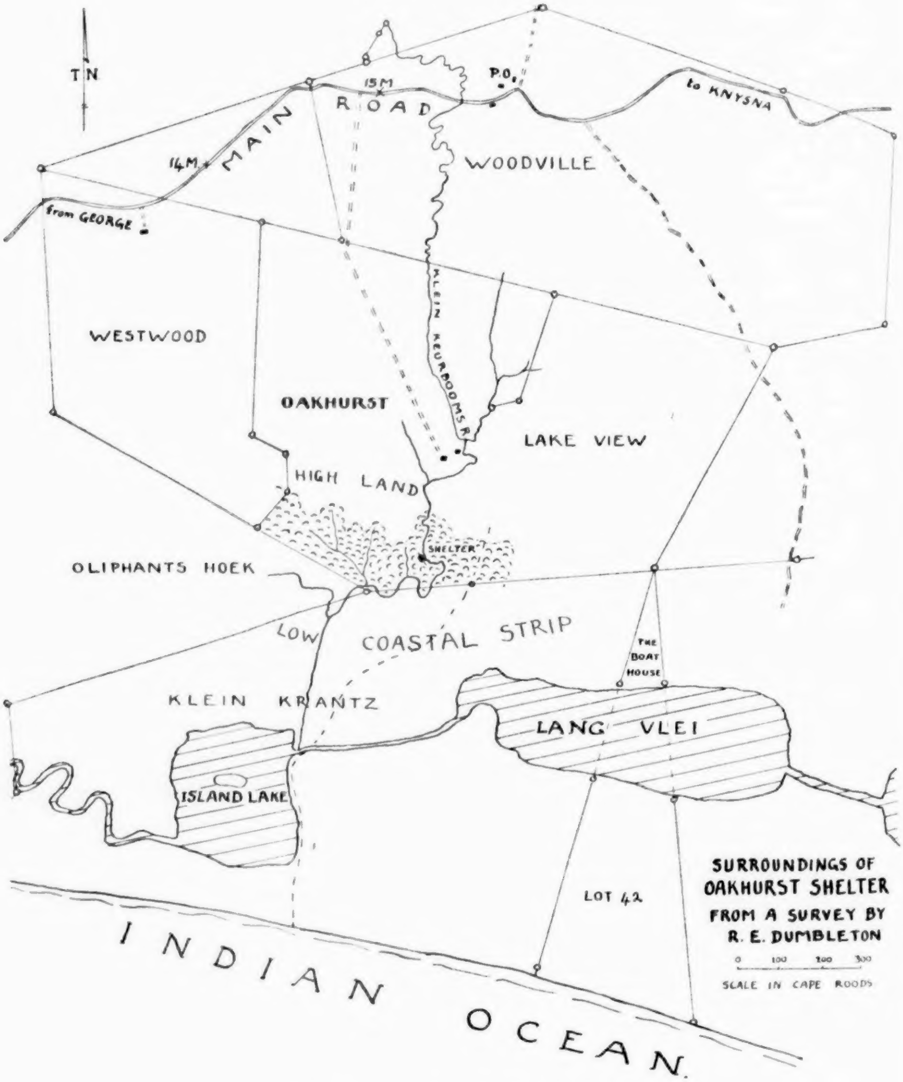

Fig. 1.—Surroundings of Oakhurst Shelter.

On the cliff, a few yards north of the gate, are several paintings in red. These show an ungulate's legs, the body having been smudged out, and two or three indistinct human figures with the common "hooked" or hooded heads. None of the paintings are clear enough to be traced or photographed. Patches of reddened rock suggest that other paintings were at one time visible. There are no paintings in the shelter itself, but the state of disintegration of the wall would not have permitted the survival of any signs of painting or engraving had these existed.

Above the shelter, on the crest of a hill a mile and a half north-west, are 37 game pits, scattered in the bush about a small natural dew-pond. They have caved in, but are still visible, and might repay aerial photography. Similar game pits are to be found on the spur to the east of, and overhanging the shelter, these latter would have been more easily accessible to the cave-dwellers. It is impossible to assign these pits to any people with certainty, but they are pre-European, and their state of preservation suggests that they are at least two or three centuries old.

The Shelter.

The whole shelter is some 50 feet in length, and the surface of the deposit falls gently with the grade of the valley. The shelter may be regarded as divisible into two parts. The deeper northern portion cuts into the cliff about 25 feet at surface level (Inner Cave). This small more or less triangular cave is cut off from the southern part of the shelter by a heavy buttress of natural rock. This buttress is embedded in the surface deposit, but, as we shall see, it is a large hanging buttress and material from the inner cave could at one time pass freely under it into the shallower shelter. Only the portion lying south of this buttress was excavated, the Inner Cave being left undisturbed, and there is every reason to presume that the richer and more interesting deposit lies within the Inner Cave, awaiting the spade of some future prehistorian.

Situated as it is under the corner of the cliff, the shelter has a talus slope at the southern end, as well as along the wide, open length of the eastern side. The forest comes right up to the shelter and trees have grown in the talus itself, so disturbing the eastern half of the cave deposit with roots and tubers that no scientific excavation was possible and only the inner portion of the shelter could be excavated. Even here, at the southern end, numbers of tubers of a monkey-rope were found, and many of these were accorded meticulous excavation as they closely resembled skulls. A careful check of the direction and the quantities of root had to be kept in order to discover the relative value of the stratigraphy of the layers excavated.

General Method.

In excavating, the southern end, comprising the shallower part of the shelter, was excavated right down to the original rock level. The remainder was "collected" for surface pottery, etc., but was otherwise not touched.

Unless specifically stated, all material for the top 72 inches was sieved through three meshes, $\frac{1}{2}$-inch, $\frac{1}{3}$-inch, and $\frac{1}{8}$-inch holes respectively. It was found to be essential to use the finest mesh in sifting every spadeful to this depth as ostrich eggshell and nacre beads pass through any riddle with a mesh larger than $\frac{1}{8}$ inch. Below this 72-inch level all material was passed through the $\frac{1}{3}$-inch mesh, and tests were regularly taken with the two additional sieves.

In excavating skeletons the greatest care was taken, and I had the good fortune to have the help of Dr. R. G. Haines, then of the Anatomy Department, University of Cape Town, on my first visit. All exhumation was done with a small bricklayer's trowel and a rubber-mounted distemper brush. These, with a specially made single-handed shovel, yielded excellent results. The complete exhumation of a grave took an average of twelve hours from the time when a grave was first recognised from the infilling or gravestones. During the exhumation of each grave a series of still photographs was taken, and in the better-preserved graves a series of stills on standard cinematograph film was taken, ten minutes between each photograph.

The ample scientific return for very careful brushwork in excavating is seen in the fact that for the first time the exact disposition of grave furniture could be observed, and even the arrangement of eggshell beads on the body could be seen *in situ*. In one instance a complicated woven bead wristlet was photographed in position and the whole wrist preserved in a wax bed. It was also possible to observe the distribution of red ochre on the bones and surrounding earth.

The habitual use of more and more exact methods in excavation will mean that the maximum of knowledge will be acquired with a minimum of disturbance to sites. The common "rooting over" of large numbers of deposits by students inevitably results in the destruction of evidence on a large scale. It is essential that those deposits which have remained untouched should be excavated with the intention of extracting every possible piece of evidence, or should be left utterly alone until such time as reasonable excavation can be undertaken.

First Visit.

Work was started in February 1932 by Dr. R. G. Haines and Mr. A. J. H. Goodwin of the University of Cape Town. Owing to the plan of the cave

excavation was begun at the southern end of the shelter, 6 feet outside the overhang of rock. This point was chosen as the deposit had obviously been disturbed by tree movements.

The ground was here 5 feet below the level of the shelter floor. The talus slope, which rose abruptly to floor level, was found to have been disturbed by root movements which had upset the upper layers very considerably. A trench 2 feet wide was first cut towards the body of the deposit, contiguous to the corner of the cliff. Almost immediately, isolated bones were found outside the overhang, but the fragmentary skeleton was found to have been so disturbed that the careful exhumation accorded it was useless.

At a depth of 2 feet was found the skull of an adult in a good state of preservation (Grave I), and further search showed the remainder of the skeleton lying undisturbed a few feet away. It became possible to reconstruct the movements of the tree roots which had separated the skull from its skeleton. A standing tree in the southern talus had fallen in such a manner as to leave a subterranean hole into which the skull had rolled one complete turn, leaving the mandible *in situ*.*

After Grave I had been excavated, Grave II was found and the skeleton carefully removed.

The trench was continued, and widened after the corner of the cliff had been passed. An attempt could now be made to evaluate the stratification. It was found that only a width of 6 feet from the rear of the cave had been left undisturbed by roots, and even part of the deposit under shelter had been disarranged by tubers.

The entire area was now carefully squared into columns a yard wide, and these were intersected at right angles by columns of the same width. The base-line was taken from the corner of the cliff, and runs almost due north. The longitudinal columns (running north to south) are called *a*, *b*, *c*, *d* respectively, the lines dividing the columns being *a*/*b*, *b*/*c*, and *c*/*d*. The columns at right angles (running east and west) are called A, B, C, D, E, . . . J, so far as excavation has reached. The line *b*/*c* is the axis or base-line. It was now possible to place every find within a few inches of position relative to the whole cave.

The deposit at the line B/C was found to consist of 3 feet of fine powdery material, divided horizontally into approximate 3-inch layers of brown, buff, black, and white. The slow disintegration observable from the top of the section downwards showed that the major part of the total mass consisted of wood ash, dead leaves, and similar forest refuse. Towards the southern end of the deposit, and immediately outside the drip-line

* An account of the graves will be found forming the second part of this series, while an anthropological description of the various skeletons will be found in Parts III and IV.

(almost coinciding with line A/B) was encountered a hard cemented layer, consisting largely of a concretion of shell. An attempt was made to work this, but it was abandoned when it was realised that the material consisted of the heavier, non-soluble elements from overlying levels which had accumulated here, cemented by lime, potassium chloride, etc., leached out from the shells and wood ash.

At a depth of 4 feet from the floor level was noted a horizontal white chalky layer which was observed to be intact. On breaking through this, Grave III was found. The skeleton was excavated with care, and further search showed that directly in front of this individual was a skull, upright and facing east (III *a*). A complete and undisturbed lower leg lay with the foot towards this lone skull. It would seem therefore that, in spite of the apparent shallowness of Grave III, it had been buried into the older grave of III *a*, disturbing it in such a manner as to completely dislocate that skeleton. It then became apparent that the few scattered bones encountered on the first day of excavation were in all probability parts of III*a*.

Mr. and Miss Dumbleton had meanwhile been making a careful examination of the eastern talus slope, the region most clearly disturbed by roots. Here were found the scattered individual bones of a child, together with the bones of buffalo (*Bos ? caffer*), *Equus zebra*, a number of large and small antelopes of modern type, and a considerable quantity of pottery fragments. All this material came from the top few inches of the deposit, and agree well with the facts developed later from the remainder of the shelter.

Work was stopped after three weeks of excavation at the end of February.

Second Visit.

On May 1, 1932, the cave was again visited by Mr. Goodwin with Messrs. J. G. Taylor and B. D. Malan of this university. The deposit was found undisturbed, and work was continued from the perpendicular section towards the body of the cave, following the cliff wall on the west. The first discovery was the skeleton of a new-born baby in an excellent state of preservation, even the *stapes* were found and removed intact. It had been buried a foot behind the skull of the skeleton in Grave III, and had been buried on its left side, facing east. The white chalky layer noted on our previous visit was intact above this skeleton also, relating the burial to the period of Grave III. No graves were noted for some time, and the horizontal bedding of the deposits could be noted in foot layers. The deposit being too dry to leave a clear section at the end of excavation, it was found necessary to continue the work in a series of terraces or steps. As far as possible these were related to the contents of the deposit.

First Terrace (0–36 inches).

0–12 inches. Well-preserved sea-shell. Wood ash containing carbon fragments and considerable quantities of leaf-mould.

12–24 inches. Topped by a buff layer, subsequent deposits suggest these buff layers to have been composed of burnt mussel, resulting from forest fires. Below this was 1 inch of heavily carboniferous earth, grading into 9 inches of white ash.

24–36 inches. The deposit is similar, white ash continues. At the base of the terrace was found a heavy accumulation of white quartz flakes and rock crystals. (Later recognised as Smithfield C.)

Second Terrace (36 inches to base of excavation).

36–48 inches. Quartz chips continue. (This is the layer from which the graves, No. III and that of the child, were dug.) Shell material was becoming more and more compacted, and shells were more numerous judging from the loose infilling of Grave III, which yielded a high percentage of shell.

At 48 inches. One or two flake artefacts of imported (non-schistose) T.M.S. were noted. These flakes had certainly been collected with the sea-shells and brought to the shelter. They are of the local Mossel Bay type, and are slightly waterworn, proving that this level post-dates the Mossel Bay period.

48–60 inches. Material as above, no further Mossel Bay flakes.

A trial trench was dug to a total depth of 10 feet without further result. On the last day Grave IV was encountered, and the skeleton was carefully shrouded and covered with earth for later excavation. Work stopped on May 8, after a week's excavation.

Third Visit.

The cave was visited by Mr. Goodwin in the middle of January 1933. Owing to the depth of the deposit, work was continued in steps or terraces, and a clear perpendicular section left at each step.

Uppermost Terrace (0–36 inches).

0–15 inches (maximum). This layer varies in depth from surface from 6 inches deep to 15 inches deep, and overlies heaps of ash which are described as layer 6–18 inches below. The apparent discrepancy between the depths of these two layers is accounted for by the undulations of the ash-heaps.

Few implements, but large numbers of eggshell beads, and shell in perfect condition. A large proportion of leaf-mould.

Stone Implements.—A very fine microlithic thumbnail-scraper. Two or three stone crescents and two good flakes of Mossel Bay type, slightly rolled. Sea-shells are present, but not common. A few flaked and broken pebbles, spherical river stones, red ochre fragments and one or two upper grindstones.

Bone Implements.—A few arrow-points, awls, etc., were found in this layer. A fine hippo tusk in good condition was found concealed against the rear wall of the shelter. It had been hacked off at the alveolar border.

Shell Implements.—A large number of carefully made crescents of *Mytilus* shell were

noted here for the first time. These are the first shell implements described in this country. Many specimens had signs of use at the mid-point of the chord of the crescent. A few specimens of circular scrapers of *Donax* shell were found, chipped to shape.

Pottery.—Potsherds were confined to the upper part of this layer only. Save for a single sherd in a grave, the greatest depth at which pottery was found was 8 or 9 inches.

Fish.—Large quantities of fish-bone were found, proving a very adequate knowledge of fishing; probably by the use of enclosures in the tidal belt of the seashore, or from netting in the abundant local lagoons.

Ornaments.—The deposit contained nacre beads, some exactly like the commoner ostrich eggshell beads; some with two holes, some oval, some comma-shaped. When the general poverty of the layer is remembered, these are relatively common. Nacre beads with edge-hatching also occur. With these were found a number of shells of *Nassarius kraussi* and *Phasianella* (? *kochi*) and of *Glycineris connollyi*, small shells of no food value, all of which had been pierced either artificially or naturally, but which could only have been collected and brought to the shelter as ornaments.

6–18 inches (underlying the above). Mainly compacted wood ash, more or less sterile. The ash has the appearance of having been sifted and heaped (these heaps form the 0–15-inch and 6–18-inch overlap). The ash-heaps at this end of the shelter can be traced.* One or two upper grindstones were found, and, at a depth of a foot from the surface, a decayed skin bag (judging from the discoloration of the ash) yielded over 600 beads of ostrich eggshell.

Two new-born babies, buried on beds of sea-grass (*Zostera capensis*) and under river-pebble gravestones, were found at a depth of 15 inches. No ornaments were included in these graves, nor was there paint on the gravestones.

18–28 inches. Heavy deposit of *Mytilus* shell, with numbers of fragments of white chips of quartz, largely from the cave wall. One bone arrow-point and an awl.

28–36 inches. Fish-bones grow very scarce. The white chips continue. Shells become scarcer, but immediately below the Mytilus layer they become more varied in type. Shell crescents relatively common; one stone crescent.

Second Terrace (36–54 inches).

36–54 inches. The soil is here regularly banded with black charcoal from hearths. Among the numberless white quartz chips were found many small circular scrapers of Smithfield C type, together with a long acorn-shaped bead, bored through its greatest length and broken. Only one large fish-bone was found, suggesting that nothing was then known of fishing methods. Shells are abundant and varied. Three oval bead-stones were found, one with the groove at one end. Judging from the collection of small endscrapers, circular scrapers, and their associations, we must regard this deposit as typical of the local quartz variant of the Smithfield C culture.

Third Terrace (54–84 inches).

54–84 inches. Shells become more abundant, and, in addition to the types noted earlier, razor shells (*Solen* sp.) and oyster shells are added, suggesting a different source of shell-fish supply. The quartz implements in this layer are larger than those in the level above, and show Smithfield B forms, further suggested by the appearance of finely serrated circular scrapers.

* Compare Miss D. Bleek, The Naron, University of Cape Town, where it is noted that ash is sifted and heaped before the huts by the modern Naron.

FOURTH TERRACE (84–108 inches).

84–96 inches. Grave IV could now be excavated, and the infilling of Grave V was encountered. Both graves contain Smithfield B implements as part of the infilling, but no later material. The remainder of this level was here so disturbed by these graves that no deductions could be made.

96–108 inches. The only Smithfield B implements in this layer come from the base of Grave IV and the infilling of Grave V. The soil consists of a hard white concretion into which Grave IV was dug. This heavy layer is generally sterile, save for a few formless chips of white quartz mainly shattered by fire. A few cooked bones in excellent preservation, each coated with a crisp lime casing, and broken by man, belong to this layer. Grave V could now be excavated, and it was found that this grave had been dug through the white layer at a date slightly earlier than Grave IV. The implements associated were of Smithfield B type.

FIFTH TERRACE (108–125 inches).

108–125 inches. Badly shattered quartz. Cooked bones persist. Earth is harder and more compact. No recognisable implements.

Work was stopped on February 8, 1933.

FOURTH VISIT.

Work was begun by Mr. Goodwin on August 9, 1933. The old trench was extended towards the body of the shelter, northwards from the line C/D, which had been reached on the previous visit. The trench was now 9 feet across. The squaring of the surface was continued, and, as the levels could now be evaluated with comparative certainty, greater care was taken to relate the excavation to the chequer-board plan. Experience had shown that below the 72-inch level the $\frac{1}{8}$-inch sieve became useless, and only the $\frac{1}{2}$-inch and $\frac{1}{3}$-inch sieves were used below that depth. In the lowest deposit only the $\frac{1}{2}$-inch sieve was used, save for occasional tests.

UPPERMOST TERRACE (0–36 inches).

General.—Though the deposit has been worked in 4- to 5-inch layers, these have here been reported in pairs as 9-inch layers, no cultural change being observable.

There is a general cultural development throughout this terrace, which is Wilton in culture, but no distinct stages can be observed. The ash-heaps described above seem to disappear as we advance into the shelter, and it is evident that this bank of ash was only built at the southern end of the shelter. Ash is now only present in a long "protection fireplace." The position of this remains constant in its relation to the rear wall for the greater part of the deposit. It is 2 feet wide, and extends from C/D to H/I, that is as far as the excavation has so far extended. It would seem to have formed a line of fire behind which the inhabitants slept for warmth and protection. It is a very persistent phenomenon, and continues right down to the base of the inhabited layers. That the fire divided the shelter longitudinally into two parts, one for sleeping and the other for general use, is proved by the contrasts in the deposits before and behind the fireplace.

Compressed and wadded bundles of sea-grass (*Zostera capensis*) lie between the fireplace and the rear wall, material certainly used as bedding, both for the living and the dead. The consistency of the deposit behind the fireplace differs markedly from that in front. In front the sea-shells are broken and crushed by much trampling, while those behind the fireplace are unbroken and whole.

0–9 inches. Pottery abundant. Unbroken sea-shells common everywhere. The soil is loose and finely divided, and appears to be composed largely of leaf-mould. The deposit is not rich as a whole. Shell-crescents of *Mytilus* are fairly common. Fish-bones abound, and sea-fish seem to have formed a large part of the diet. A number of bones of small buck, *Hyrax capensis*, etc., suggest a certain amount of hunting, but no large game is found.

The pottery is varied. Many sherds are thin, burnt black on both faces; while many are thick, sandy, and crude. All show white quartz inclusions; some of the clay used was sandy.

Three types of lug were found: a plain nipple, a raised boss pierced horizontally for suspension, and an internal thickening, pierced from the outside by a curved hole horizontally. Designs vary, all consist of incised lines in different parallel hatchings never crossed, and confined to the neck. It is important to remember that the pottery is completely confined to the top 9 inches of loose uncompacted deposit. There is thus every reason to believe that pottery is here a very recent element, and that all these varied types were used by the same folk at the same period. (For description of pottery, see Part V of this series.)

Stone implements are not abundant, the commonest type is a waterworn pebble fragment, with a straight scraper-edge worked across one end. Generally the rest of the flat pebble surface has been left intact.

A baby skeleton was found near the cave wall, 9 inches from the surface, 2 feet north of C/D.

9–18 inches. Shell crescents abundant. Pottery ceases altogether. The deposit remains otherwise much the same. Shells, fishbones, and pebble scrapers still persist. A fragment of bored stone was found.

18–27 inches. Along the back of the shelter some material has intruded into a crack between the deposit and rock. Most of the shell crescents are from here, though a few occur throughout the layer. Fish are less abundant. There is a large proportion of wood ash. A broken string of beads was found at 20 inches.

27–36 inches. Shell crescents continue, and two small stone crescents were found. A single pottery fragment was found at the base of the grave of a year-old child. There was no gravestone, nor were ornaments or implements included in the grave.

35–36 inches. (Test.) Owing to the finding of these two stone crescents at the base of the previous layer, a shallow test was isolated. This revealed a few shell crescents and one or two normal Wilton crescents of stone. It is thus certain that the more usual Wilton occurs here, marking the beginning of the developed (shell) Wilton which continues to the surface.

Second Terrace (36–54 inches).

36–45 inches. Shells are rarer. The protective fireplace continues, and here too the shells are broken in front of the fire, but whole behind it.

A few Wilton crescents of stone come from the top of this layer, placing the Wilton divide at 36 inches exactly. The remainder of the deposit includes many thousands of chips of white quartz and quartz crystal, with thumbnail scrapers and circular scrapers of

Smithfield C type. *Mytilus* continues, but not a single shell-crescent. A bone sharpener of stone is from this level. The abundant chips suggest that this level was used as a workshop site.

Very few fish-bones occur at this level. It is evident that, though the inhabitants ate fish, they had little means of catching them.

45–54 inches. Smithfield C. without change. The deposit now contains little "meal-piles" of shell, mainly *Donax serra*, apparently representing the refuse from a single meal. They are roughly lenticular piles, and cover a circle of 18 inches, standing to a height of 3 inches. In addition to these piles of unbroken shells, shell fragments are common.

At this level a peculiar "floor" was reached. It seems to mark off the Smithfield C deposit from the underlying Smithfield B. Over the greater part of the floor it is not possible to differentiate between the two deposits absolutely, owing to the intrusion of graves. North of the E/F line the floor becomes more evident and deserves separate description. There is every reason to believe that the floor represents the action of two or perhaps three devastating forest fires which dropped ash and carbon into the cave, and even burnt the shell accumulation to form a buff deposit.

Over the greater area north of E/F the floor takes the form of three layers (buff-black-buff), two buff layers with a thin but very marked layer of carbon between. The preliminary test was taken over a small area a foot wide by 2 feet long from north to south, immediately west of b/c in column H.

51–53 inches. No implements. Buff earth, full of burnt blue mussel.

53–54. Deposit remains the same. One shell contained fragments of red ochre. One worked bone. One small endscraper.

54–55. Black carbon. No implements. Burnt mussels.

55–56 inches. Buff earth returns. No implements. Mussels.

56–59 inches. The buff layer dies at the top of this level and is replaced by a slight deposit of carbon. No implements except one pebble flake of midden type at the base of the level.

The depth of the black layer interlying the two buff layers was now taken at various points on the chequer board, with the intention of separating the Smithfield C from the underlying Smithfield B deposit with greater accuracy.

Depths of Carbon Layer (see fig. 2).

Where the carbon layer is replaced by midden intrusion from the Inner Cave the figure is marked with an asterisk.

Intersection of North Section with East Section	47 inches.
c/d	49 ,,
Grave VII	*54 ,,
b/c	*56 ,,
a/b	*57 ,,

Intersection of shelter wall with	G/H	*57 inches.
	F/G	*64 ,,
	E/F	*66 ,,
Intersection of mid-line *b/c* with	Grave VII	54 ,,
	G/H	55 ,,
	F/G	Grave XIV intrudes.
	E/F	67 inches.
	D/E	69 ,,
	C/D	76 ,,
Intersection of line *a/b* with	G/H	*57 ,,
	F/G	64 ,,
	E/F	65 ,,
	D/E	69 ,,
	C/D	72 ,,
Intersection of East Section with	North Section	47 ,,
	G/H	52 ,,
	F/G	57 ,,

The buff-black-buff layer peters out south of this, and no observations could be taken.

THIRD TERRACE (54–84 inches).

54–60 inches. The ground is very disturbed by graves, but sufficient evidence remained to make some reconstruction.

Below the "floor," Smithfield B continues under the midden and lower buff layer. The Smithfield B material underlies the shallower graves except at the north end. Shell is still common, and midden-types of implements persist. The deposit is sterile wherever the buff-black-buff layer is found intact.

60–64 inches. Behind *b/c* the deposit contains most of the deeper graves. The midden layer, or false talus from the Inner Cave, is seen to start above the 54-inch level at the northern end, and passes down so that it underlies Graves VI, VI *a*, and XI, while all the other graves of this level are buried into the midden. In places the fawn-coloured earth of the lower buff level is visible below these graves, proving the base of the midden talus to be coincident with the carbon layer. In front of the *b/c* line, where graves are absent, Smithfield B implements occur fairly plentifully.

Owing to the difficulties entailed in exhuming the various skeletons exposed, it was necessary to leave these to dry before removing the bones. The whole of the western part of the shelter was therefore left at this point as a shelf containing the whole of column *b*, and column *a*, while work was continued on columns *c* and *d*.

64–68 inches. Smithfield B continues, but implements and flakes become much rarer. At a point in *b/c* the infilling of Grave XIV intrudes. This is the only part of the deposit in which Smithfield B implements are common. A fireplace similarly intrudes at the middle of column E, where it intersects *b/c*.

68–84 inches. Almost sterile. A few shells, quartz chips and flakes, fragments of schistose Table Mountain sandstone, and burnt bone are found. The latter are well preserved, and coated with a thin crust of lime.

FOURTH TERRACE (84–108 inches).

84–108 inches. Hearths still occur with burnt bones. Man-made flakes are thinly scattered and amorphous. The hearths quite certainly represent single fires, and merely leave thin lines of charcoal at various scattered points in the deposit.

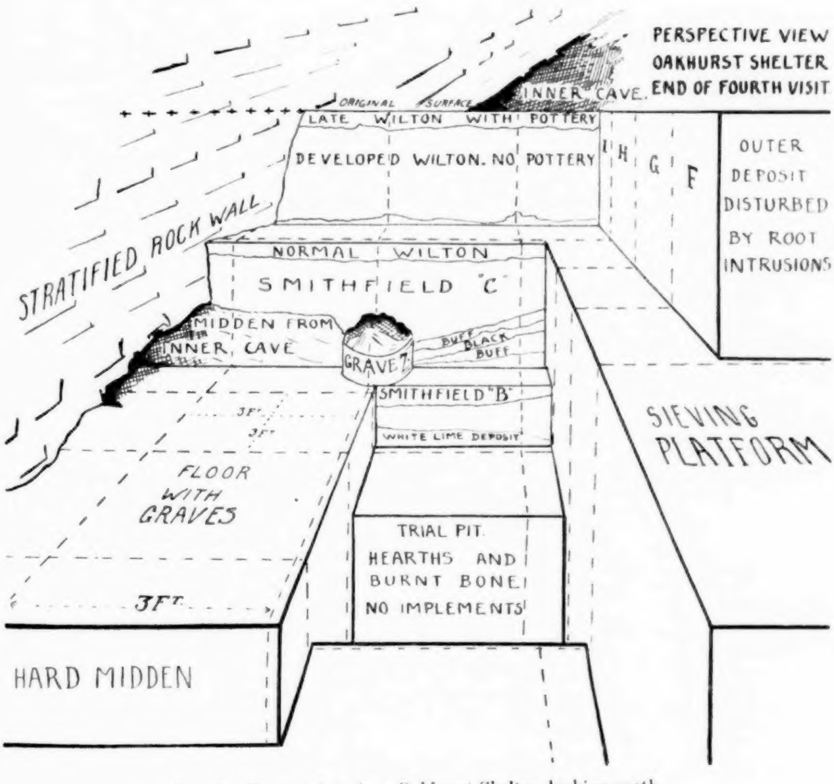

FIG. 2.—Perspective view, Oakhurst Shelter, looking north.

FIFTH TERRACE (108–126 inches).

108–126 inches. Identical with fourth terrace. No recognisable implements could be found, though relatively large numbers of burnt and shattered splinters of white quartz are present. These are most probably fallings from the cave roof.

The whole series of deposits below 68 inches shows that the shelter was not inhabited earlier than the coming of Smithfield B man. Where implements occur, they belong to the infilling of Grave XIV, or to the

hearth intrusion. The isolated scattered fireplaces suggest that haphazard hunters travelling between the uplands and the seashore made use of the shelter for a night or a meal. The reasons why the shelter was not then inhabited are evident. The shelter at the beginning of excavation had consisted of two portions. The sheltering rock over the southern (excavated) portion stood out at an angle of about 45°, and the height above the surface of the deposit was 9 or 10 feet at the mouth of the shelter. The northern (Inner Cave) portion jutted at about 35° and a shelter which was only 6 feet high at the mouth was left. When the 7-foot level is reached we thus have two portions, one 17 feet high at the mouth and of no great depth, the other 13 feet high at the mouth and of uncertain depth. The rain and wind would at that time have beaten in, and little protection would have been provided by the overhang in the shallower portion of the shelter.

The Inner Cave is separated from the southern portion by a hanging buttress jutting from the cave rear. At a depth of 55 inches on the line G/H the underside of this buttress was reached (see fig. 2). From the Inner Cave a heavy midden deposit has been extruded, the base of the midden coinciding with the carbon layer between two buff layers which forms the "floor" described above. The heaviness of the midden layers in the Inner Cave in contrast with the earthy deposit of the outer shelter shows that the Inner Cave was used to a greater extent at that time than the Shelter. There is thus reason to believe that when columns *c* and *d* are continued northwards and worked back into the Inner Cave, much richer deposits will be encountered. It is at present considered desirable to leave the Inner Cave deposit severely alone, and to give it more expert attention at some time in the distant future.

Work on the fourth visit had started at the line C/D and had been carried a total distance of 16 feet north, to a new face 1 foot north of H/I. In this area (roughly 9 feet by 16 feet) columns *c* and *d* had been dug to a depth of 126 inches, while columns *a* and *b* had only been dug to the level of the "floor," and the skeletons lying exposed were removed (see fig. 2).

Work stopped on September 22, 1933.

Fifth Visit.

Work was recommenced on February 5, 1934, by Messrs. Goodwin and B. D. Malan. The portion of the deposit west of *b/c*, which had been left after the removal of the skeletons, was attacked. The whole of the shelf, mainly underlying the floor-level (see above), had been dug to the middle of the third terrace, a depth of 68 inches from surface, and work was continued from here.

THIRD TERRACE (54–84 inches).

68–78 inches. It was noted that the deposit grew richer towards the back of the shelter and towards the Inner Cave. The "floor" was observed to descend towards the rear of the shelter and towards the southern end. At C/D, for instance, it falls to a depth of 75 inches. At D/E the depth is about 78 inches.

Throughout the deposit *Mytilus*, *Patella*, oyster, etc., are abundant in the "floor" layer. A few Smithfield B implements intruded through the floor layer, but from careful observation it would seem that the Smithfield B implements do not belong to the deposit below that level. The implements belong to grave infillings, or have been forced below the lower buff layer, which can now be said with certainty to commence the Smithfield B series. Here and there implements of this type have been carried through by the numerous baby graves, the contents of which were generally in too bad a condition to merit saving. One specimen from square G *a* could be kept.

78–84 inches. In squares D *a* and D *b* fragments of the lower buff layer remain at the top of this layer. Below this level few shells occur and implements become distinctly poor. One or two flakes show vague Middle Stone Age affinities, but are not sufficiently clear to allow of any deduction.

FOURTH TERRACE (84–108 inches).

84–108 inches. Very little recognisable material. The few rough spalls collected show Middle Stone Age affinities of an indefinite sort. The soil contains much lime and white ash, and reacts strongly to hydrochloric acid. The lime is apparently due to the solvent action of a stream which at this level ran through the rear of the shelter from north to south. The deposit is extremely hard and compacted in parts.

Against the rear wall of the cave was noticed a darker patch of earth, obviously infilling of a gap formed between the deposit and the cave rear. This had commenced at the 68-inch level and yielded a few Smithfield B implements. A grave was also suspected, and the knee of Skeleton XV was encountered. The body lay against the rear wall of the shelter. It had either been buried into the gap, or the grave dug into the natural infilling.

In square E *b* three gravestones, a large dropping from the cave roof and two 4-inch pebbles marked the presence of Grave XVI. The large gravestone and the slab from the roof both showed red ochre, but bore no design.

FIFTH TERRACE (108 inches to base).

108-inch Base. At a depth of 105 inches a yellow sandy layer was encountered. It was almost sterile, save for a few burnt bones. At the base of this sandy layer (113 inches) a dark soil band appeared, and at 115 inches a completely sterile sandy layer was found. This rested upon a projecting ledge of rock from the rear wall. This projection forms at this point the floor of the original shelter.

In column G the upper sandy layer was met at a depth of 100 inches. It here suggested disintegrated shelter wall, and contained a few burnt animal bones and chips of quartz.

A trial trench was now dug in column F, following the steeply dipping cave floor. The fall is covered with a level layer of yellow sand, completely sterile, and an extension of the lower sandy layer. The complete absence of carbon and mould suggests that the rock falls from which the sand is seemingly composed must have fallen and disintegrated *in situ*.

Work stopped on February 9, 1934.

Sixth Visit.

Work was begun on February 19, 1935, by Mr. Goodwin.

The remainder of the fifth terrace was taken down to floor level, and the general conditions were found to be identical with those previously noted. The burnt bones and carbon which occur throughout the lower levels rest upon the upper sandy layer, and no human remains of any sort were discovered in the yellow sand deposits, nor in the interlying dark earth deposit. The yellow sand rests upon rock floor.

Uppermost Terrace (0–36 inches).

0–15 inches. Excavation had to be continued a further 30 inches northwards in order to release the underlying graves which had been left in position. The upper 8 inches yielded pottery, and the material found was generally the same as that previously encountered at this level.

15–36 inches. Pottery ceases. Typical Oakhurst Wilton, with shell-crescent ostrich eggshell beads, etc. Little of new interest. The protection fire continues, and the lack of any finds of importance in the ash becomes more marked. All the interesting finds come from behind the fireplace.

At 32 inches a heavy intrusion from under the overhanging buttress, which divides the Inner Cave from the rest of the shelter, was first encountered. It showed itself as a talus of fallen shell, forced under the buttress from within, suggesting that the deposit in the Inner Cave was at that time slightly higher than in the outer shelter. Tucked under the buttress, where it had been hidden, was a lump of yellow ochreous clay, 2 inches in diameter.

As Grave VII was now left free for excavation, no further excavation of the deposits was attempted. Above the grave region the earth is soft, and cuts sharply and clearly into the midden talus from the Inner Cave, shell crescents occur, and it is clear that the grave is of Wilton age, and had been dug into the midden but refilled with a mixture of loosened midden and Wilton debris. The undisturbed midden immediately west of the grave is completely sterile save for some chipped river pebbles. On exhuming this skeleton it was found that the interment had disturbed another skeleton a little to the west. The sacrum lay alone next to the feet of the skeleton in Grave VII, while the vertebrae were scattered in all directions without order.

Grave XVII was encountered at the back of Grave VII and is distinct from the disturbed fragments. The skeleton was excavated by a European prehistorian, Miss M. Nicol, who was visiting the shelter. The body was buried into the midden and is probably of Early Wilton date. It had been buried partly under the buttress dividing the Inner Cave from the remainder of the shelter, and thus could hardly have been interred from a level higher than 30 inches.

Fragments of another skeleton, probably the same individual as had

been encountered earlier, were found disturbed by Grave XVII. Some of the bones lay on the shoulder of that skeleton. If these bones prove to have been those of the same individual, then they represent an earlier interment than either Grave VII or Grave XVII.

Partly to clear the excavation, and partly to discover the richness of the overflow from the Inner Cave, column I was taken to a depth of 60 inches.

36–60 inches. The deposit remains the same as that described previously from similar levels, but the Inner Cave yielded only midden overflow, containing nothing of any importance, a few chipped river pebbles being the only implements.

Work was stopped on February 22, 1935.

ARCHAEOLOGY OF THE OAKHURST SHELTER, GEORGE.

Part II. Disposition of the Skeletal Remains.

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(With Plates III–VIII, and four Text-figures.)

(Read April 21, 1937.)

It will be noted that the greater number of the graves lie at a depth of between 50 and 65 inches from the surface, and that they have come from a relatively small area—an area 7 feet long by 5 feet across includes more than half the graves. The Smithfield B people seem to have buried their dead to a depth of about 15 inches, while the later Wilton folk buried their dead at a minimum depth of about 30 inches. The bottoms of the graves thus tend to lie at much the same level, and earlier graves have consistently been disturbed by later burials, in some cases more than once. For this reason the relatively undisturbed interments have been called graves and numbered in Roman figures. The disturbed remains have been given grave numbers with the addition of a letter of the alphabet. A table is given later collating the Roman grave-figures with the numbers used by Professor Drennan in his report. In some cases where graves have been disturbed twice, it has been impossible in the field to associate the disturbed bones correctly, and mistakes have necessarily been made (judging from later excavation and from the careful work of Professor Drennan). Bones found in one grave thus prove to have belonged to another. For example, VI *b* and VI *d* almost certainly form parts of Skeletons VIII *a* and VIII *b*. These questions have been left in the more competent hands of Professor Drennan.

Two other factors militate against the finding of complete skeletons: the presence of roots in certain portions of the more exposed deposit, and crushing by overlying material, particularly gravestones. Where the roots have come into contact with the bones, they have used the bone as fertiliser. Where heavy gravestones have pressed directly on the bone, it has crumbled to a fine dust, leaving only an impression on the overlying stone, with no hope of preservation or reconstruction.

It will be seen therefore that especial care has had to be taken in determining what may be regarded as grave infilling, and what may be regarded as "furniture." The general rule has been to collect, but ignore grave infilling, except to note, as a clue to dating, the latest type of implement or other relic included. This latest implement dates the last disturbance of the grave, and consequently the various burials are dated as earlier than or contemporary with that implement. In the immediate region of the skeleton extreme care was taken to excavate only with the rubber-mounted distemper brush, and every means to discover the exact disposition of grave furniture was employed. It will be realised that no infilling has been included in the grave furniture, but only such material as it was possible to relate absolutely with the skeleton in question.*

Grave I.—Depth, 24 inches. In talus at southern end of shelter. Excavation at first suggested that the skull lacked the jawbone and all other bones. Further exhumation showed the remainder of the skeleton *in situ* 2 feet to the south of the skull. The burial had been on the left side, fully flexed, facing east, head to south. It was observed that the skull had rolled a full turn from its original position, a movement which could only have occurred as a result of a falling tree having raised the overlying earth sufficiently to form a wide gap. The skull and skeleton were photographed in their divided positions (Plate IV, A).

Grave II.—Depth, 40 inches. A foot deeper than the skeleton in Grave I. As it lay with the feet directly below the backbone of the former skeleton, it was necessarily the earlier burial of the two. Fully flexed, on right side, facing south, head to west. This skeleton, too, had been slightly displaced, and the skull was found twisted round, in a small corner under the overhanging rock, apparently forced there by the same tree movement which disturbed Grave I. The skull was badly crushed, but has been reconstructed.

Grave III.—Buried beneath a horizontal white sealing layer at a depth of 48 inches. Fully flexed, lying on right side, facing south, head to east. The entire skeleton was intact and undisturbed. Allowing for compression of overlying material, this skeleton could not have been buried in a grave originally deeper than 18 inches, as is proved by the intact overlying white layer. Smithfield B or C.

III *a*.—A complete and undisturbed lower leg and foot, with the foot

* Note on location of skeletons. Where the skull was found, all depths, etc., related to the position of the centre of the skull. Where no skull was found, figures relate to the centre of the region occupied by the disturbed bones. The word plus means, in all figures, north of; thus C/D plus 25 inches means 25 inches north of the line C/D, the line marked on the chequer board. By distance from the cave rear is meant distance at right angles to *b/c*.

lying towards a disturbed skull. An earlier interment than Grave III and disturbed by that burial. Smithfield B (Plate IV, B).

GRAVE IV.—Depth of gravestone, 88 inches; bottom of grave, 105 inches. The skeleton was buried from a Smithfield B layer, as is proved by a white intact layer at 86 inches. Skeleton lay on right side, facing west, head to north. The left arm lay behind the back, the remainder of the body was fully flexed. The remains suggest a twelve-year-old boy. Skull badly broken, rotted, and crushed. Several Smithfield B implements were associated, some lying beneath the body. Owing to the rotted state of the material this specimen could not be submitted to Professor Drennan.

GRAVE V.—This grave does not seem to have been affected by the general hardening and compression of the adjacent earth, save that the skull was crusted with a limy coating. Gravestone, 95 inches. Centre of skull, 115 inches. The skeleton lay partly on a shoulder of rock protruding from the cave rear, and had been crushed as a result of the overlying deposit. The skull is fairly youthful, but thick; it has an infantile jaw. Both skull and sacrum show very marked signs of red ochre, an interesting parallel to European burials. Smithfield B.

GRAVE VI.—Very considerable disturbance has taken place at this point, and the remains of six individuals were found lying on line E/F or in Column E (Plate V, A, B, and C).

	Vertical depth of skull.	Distance from chequer lines.	Distance from cave rear.
VI	60 inches	D/E plus 8 inches	36 inches
VI *a*	64 ,,	D/E ,, 9 ,,	28 ,,
VI *b*	63 ,,	D/E ,, 25 ,,	20 ,,
VI *c*	60 ,,	On E/F	48 ,,
VI *d*	66 ,,	D/E plus 25 inches	20 ,,
VI *e*	67 ,,	D/E ,, 14 ,,	21 ,,

It will be seen that Skull VI *b*, consisting only of the upper facial portion, overlies Skull VI *d*. Actually, the upper teeth of VI *b* stood directly on the upper teeth of VI *d*. Both possibly belong to Grave VIII, excavated later. Skulls VI and VI *a* lie side by side, but VI *a* is an older burial, completely underlying VI and hardly disturbed.

VI.—On left side, fully flexed, head to south, facing west. The skeleton mainly overlies VI *a*. Implements in the grave prove it to have been of Wilton age. The skull was almost vertical, and the skeleton lay beneath eight gravestones which were encountered at 45 inches from surface. The whole grave had been outlined in sea-grass (*Zostera*).

On the neck of VI, below the jaw, were found three implements resembling Mossel Bay types. In front of the face lay a round river pebble, slightly used as a grindstone. Behind the skull, and touching it, was an ostrich eggshell, pierced with a ¼-inch hole at one end. At the breast lay another, near the grindstone another, and a foot away, but still in front of the skeleton, a fourth. Before the face lay an ivory arrow-point, while on the breast an ivory arrow-head, consisting of foreshaft and linkshaft, lay in correct position (fig. 1). On the right side lay a small mountain-

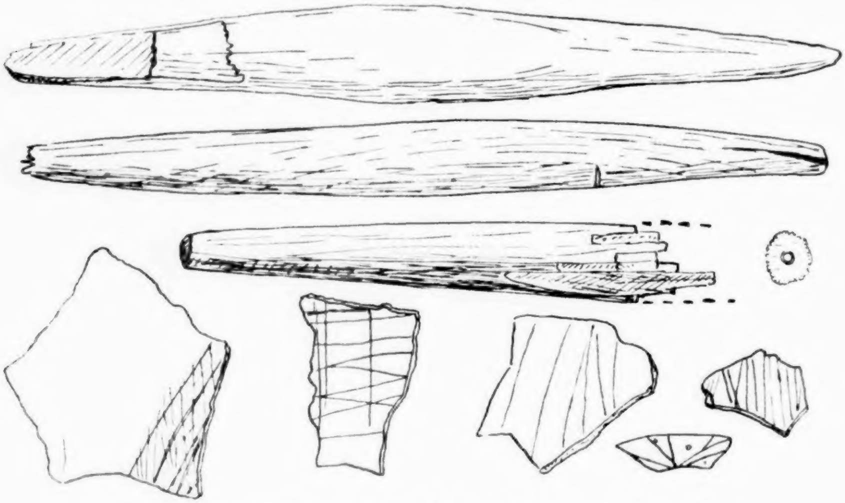

FIG. 1.—Ivory arrow-points and linkshaft, with ostrich egg-shell bearing design, and a small nacre bead. Grave VI.

tortoise shell, containing a blue pigment; beside this were two lumps of ochreous clay, one light red, the other red brown. At the hip lay an empty mountain-tortoise shell.

A baby lay in the ventral region of the skeleton, the bones divided. This is obviously part of VI *c*. Two large sea-shells were found on each side of the child's skull, and, as though hung about its neck, were two pierced Conus shells. Parts of a fifth ostrich eggshell were lying between the child and the hip of VI.

VI *a*.—An earlier interment underlying VI. It had its own gravestones, three of which bore signs of red ochre, but no paint. The skull was that of an adult, very much rotted, apparently through contact with Skeleton VI, and through having been crushed by the gravestones. The skeleton lay on its right side, facing east, head to south. Four or five

Wilton crescents of stone serve to date the burial as Early Wilton, buried from 36-inch layer.

On the right thigh, with marked signs of red ochre in the surrounding earth, lay an oval bored stone pierced down its major axis. One end contained broken fragments of a mass of black resinous substance; the other end contained an unbroken series of fish vertebrae. A red-ochre powder coloured the area between this bored stone and an upper grindstone. Near the bored stone lay four pierced Conus shells and three pieces of ironstone (probably from the surface of the 300-foot peneplain above), which had apparently formed part of a girdle about the waist. On the right wrist, which had been forced against the sternum, was found a

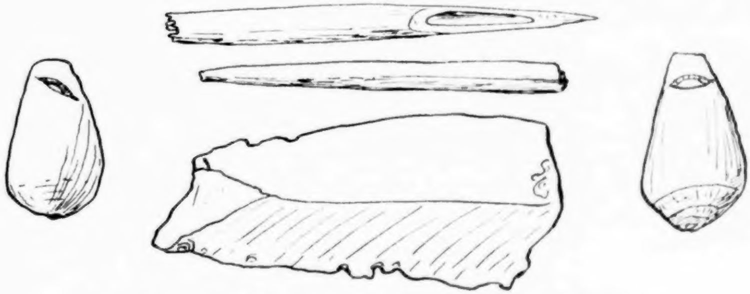

FIG. 2.—Conus shells, arrow-points, and a flake of Mossel Bay type. Grave VI *a*.

bracelet, consisting of an intricate band of ostrich eggshell beads, $1\frac{1}{2}$ inches wide, with beads in position. The wristlet was photographed, and fixed in wax for future development (Plate VIII, B).

Behind the pelvis, under a large stone with red paint on it, were three river pebbles about 3 inches diameter with red ochre on them. With these was a mass of powdered ochre mixed with soil, also two water-worn flakes of Mossel Bay type (fig. 2), half a broken palette, a large crystal worked as a circular scraper, a few Donax shells filled with red ochre, and a crushed ostrich eggshell bored at one end. The whole grave was lined with sea-grass.

Near the skeleton, and apparently belonging to it, were found two more slate palettes, two bone arrow-points, and a mass of black resinous material. This latter bears the imprint of a flake, and of a thin bone about $\frac{3}{16}$-inch in diameter. The superficial similarity of the resinous mass to that found in the bored stone suggests that they belong to the same grave.

VI *b*.—On excavation this was found to consist only of a mask, from the frontal region to the teeth. It was vertical and immediately overlay

the skull of VI *d*. Both these skulls may have dropped from the general region of Grave VIII.

VI *c*.—An isolated fragment of a child's skull, not *in situ*, and obviously part of the baby skeleton found in the ventral region of Skeleton VI.

VI *d*.—A skull lying upside down, the teeth lying against those of VI *b*. The jaw was missing and the skull crushed. This burial had been disturbed by the burial of VI, or had possibly fallen from the region of Grave VIII (Plate V, B).

VI *e*.—Under the large water-tortoise, on the shoulder of VI *b*, lay fragments of a skull, badly decayed and hardly recognisable. The bone fragments were small and spongy, forming a fine powder when touched. Whether the water-tortoise is a part of the disturbed burial or of that of VI *a* is uncertain. It is more probably related to VI *a*.

A baby skeleton was found on a ledge of rock protruding from the cave rear at a depth of 57 inches from surface and on the line D/E. Near this were found a few disturbed adult bones, which could not be related to other remains.

Grave VII.—Depth 50 inches, at the junction of H/I and *b/c*. On completing the 50-inch layer on the fourth visit, this grave was first encountered, and had to be left for later excavation. On the sixth visit, once the grave had been left free for excavation, four gravestones were removed from the skull region. One stone was possibly a fall from the cave roof, one had been used as a lower grindstone. There were no signs of paint on the stones. With these in the same region were three or more ostrich eggshells bored at one end. The earth forming the infilling is soft, and cuts straight down into the midden. Forming part of the infilling were Wilton implements, with shell crescents. Four stone crescents occur in the grave, which is certainly of Wilton age.

The skeleton proved to be that of a child of about seven years. Most of the skull was broken. The body was flexed and lay on its right side, facing east, head to the south. A number of shells of *Donax serra* lay along the spinal column. A girdle consisting of a single strand of ostrich eggshell beads was strung round the waist. Red ochre was present on the skull and the neighbouring bones (Plate VIII, A).

On exhuming the skeleton in Grave VII, it was found that another skeleton, a little to the west of this grave, had been disturbed by Grave VII. The sacrum lay next to Grave VII, while the vertebrae were scattered about without order. The fragments later found in Grave XVII may prove to be part of the same individual.

Parts of a skeleton, apparently disturbed by Grave VIII, were found. Depth 42 inches, on F/G, 18 inches from cave rear. Apparently a Wilton

burial. A child's skeleton was found at a depth of 40 inches, at F/G plus 13 inches, 18 inches from the cave rear.

Grave VIII.—This grave proved difficult: it had been first observed after Grave VII, but overlying material and graves IX and X had to be excavated before this complex could be touched.

VIII *a*.—Immediately after removing the child (depth 46 inches, F/G plus 7 inches, 12 inches from cave rear, described above) were encountered a number of disturbed bones (VIII *a*). They lay under the child and were over, between, and under the gravestone of Grave VIII, at a vertical depth of 54 to 58 inches, at E/F plus 24 inches, within 18 inches of the cave rear.

VIII.—The gravestones lay at a depth of 54 inches from surface, and the burial was 4 inches below this. From cave rear 18 inches, at E/F plus 6 inches. The skull extruded from the grave in the region of Skulls VI *b* and VI *d* (see above), which had been disturbed by the later burial of VIII *b*. It seems likely that VIII, and parts of a skeleton found with it (probably VIII *a*), belong to the fragments of skull previously described as VI *b* and VI *d*, which lay between this grave and Grave VI.

VIII *b*.—This proved on excavation to be the last burial into this grave, and the only skeleton intact. The skull was encountered at a depth of 60 inches, on line F/G, 22 inches from the cave rear. The skeleton lay on its right side, fully flexed, facing west, with the head to the north, under nine gravestones. The skull was crushed and in bad condition save for the facial portion. On the throat, actually in the mandible, was found a pierced oval of nacre and a piece of ochreous shale; these had been strung, presumably on the same string which supported a mountain-tortoise shell at the nape of the neck. All bones show what appear to be rheumatic nodules. Though every care was taken, only Skeleton VIII *b* could be isolated with certainty.

Grave IX.—Very probably young twins, and certainly a double burial (Plate VI, A).

IX.—Depth, 43 inches.	F/G plus 19 inches.	11 inches from cave rear.
IX *a*.— ,, 42 ,,	F/G ,, 23 ,,	8 ,, ,, ,,

Skeleton IX was fully flexed, but IX *a* had only been flexed sufficiently to fit behind IX. The left arm of IX *a* lay across the shoulder of IX as though embracing him. No gravestone. Both lie on the right side, facing east, head to the south.

IX.—In the left orbit of Skeleton IX was found a large broken crystal, roughly an inch in diameter, and with a diamond facet as large as an eye and correctly placed. This may be due to chance, or may have been placed in position at the burial. No other crystals were found, nor beads or ornaments. Probably Wilton.

IX *a*.—A considerable amount of red ochre was left in the cast of Skull IX *a* in the soft earth, especially in the posterior parietal and upper occipital regions. Behind IX *a* at the contact with the surrounding midden were found the two halves of a broken grindstone; this may belong to the midden. These two skeletons had been buried into the heavy midden deposit, but the grave had been filled with soft cave-earth. The only implements observed in the infilling are of Smithfield C type, but the position of the mouth of the grave strongly suggests that these are Wilton burials.

Overlying Grave IX was found the disturbed skeleton of a child, upset by Grave VIII or IX. Only the skull had been moved. It is possible that this grave had been buried into Graves VIII and XII, but not sufficiently deeply to disturb them, and next to Grave IX. Depth 46 inches, at F/G plus 7 inches, 12 inches from cave rear. The body lay on its right side, facing west, head to north, and lay in sea-grass. The presence of two pierced shells in the neck region suggest that the burial was Wilton; the burial was certainly later than IX.

Grave X.—Depth 60 inches, 32 inches from cave rear, F/G plus 27 inches. The grave lay immediately east of Grave IX. The skeleton lay on its left side, head to the south-east, facing north-west, body fully flexed. Several gravestones overlay the body; none were painted. Behind the skull or resting on it were an ostrich eggshell and a spherical bored stone. Another eggshell or parts of the same one rested on the face.

The gravestones had collapsed and crushed everything above the sacrum. Many hundreds of eggshell beads were found. The body seems to have been buried on top of a heap of shells of *Donax serra*, and 59 of these were found in front of the face. Parts of another skull, in bad condition, were found in the ventral region.

In removing the contents of Grave X, the skull of Grave XII (see later) was encountered. It lay directly beneath Grave IX, and had been disturbed by Grave X.

Grave XI.—Depth 69 inches, 36 inches to cave rear, on E/F. The bones were in varying condition, the roots having completely destroyed some, leaving others intact, while the southern end of the grave had been disturbed by Graves VI and VI *a*. So far as could be discovered, the skeleton lay on its right side, skull to south-west, facing south-east. A slate palette was found with the skeleton.

Grave XII.—Depth 61 inches, 18 inches from cave rear, F/G plus 18 inches. This body had been buried under and before IX and IX *a*, and next to Grave X. It had also been disturbed by Grave XIII. A child over twelve years old, sutures well knit but unfused. Four cut Conus shells were found round the neck, a spoon-shaped nacre shell at the nape of

the neck, another at the throat. At the base of the spine was a third. A few beads. The infilling suggests that the burial was either Smithfield C or Wilton, giving a Wilton date to Grave IX and IX *a* (Plate VI, A).

GRAVE XIII.—(Near Grave XI.) Depth 68 inches, 30 inches from cave rear, on line F/G. A young skeleton. Part of a broken palette of ivory was found in the grave, also an ostrich eggshell overlying a mountain-tortoise shell, and a fragment of red ochre, all behind the skeleton (Plate VI, B).

Only the upper part of the body was found, the remainder probably having been disturbed by Grave XI. The skeleton lay on its right side, head to west, facing south. The skeleton (like X) had been buried on a heap of Donax shells, possibly the talus from the midden from the Inner Cave.

The ivory palette, split into fragments, and about thirty double-pierced

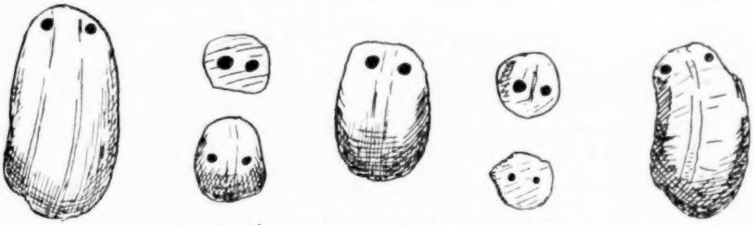

FIG. 3.—Pierced nacre ornaments. Grave XIII.

nacre ovals were found about the neck (fig. 3). Red ochre was visible on the limbs and skull.

GRAVE XIV.—This is the remainder of an interesting grave which has been cut into by XI and XIII. The body from the arms down was present, but the bones were in varying condition, the vertebrae from the neck to the base of the spine having been completely crushed by the gravestones (Plate VI, B).

Depth 68 inches, 52 inches from rear wall, on F/G. The skeleton had lain on its right side, facing south-east, the spinal column pointing south-west. Half flexed. Five gravestones overlay the body; two were river boulders, both show use as lower grindstones and bear red ochre paint, no design. The right hand was outstretched and grasped one gravestone, a natural angular rock. The gravestones lay directly on the spine and left arm, which had been crushed to a fine powder, leaving only an impression on the rock. The skull and shoulders have probably been displaced by Grave XI.

GRAVE XV.—Depth 115 inches, skull lay on C/D and a little to the east of *a*/*b*, close to the rear wall of the shelter. No gravestone of any sort

can be associated with either the mouth of this grave or with the bones. On excavation the skeleton proved to be a full-grown adult. Lying on right side, head to north, facing west. Both feet were completely missing, having been displaced by Grave IV, which lay on the same ledge immediately south of this grave. Grave XV is thus earlier in date than IV. It lies similarly on the sandy ledge now recognisable as the disintegrating shelf projecting from the cave rear which here forms the floor. The skeleton is thus close to the rear wall of the shelter. The grave had been dug through a hard limy layer, which elsewhere seals the cave deposit. The grave infilling consists of soft dark earth, mould mixed with lumps of the limy layer, and contains a few Smithfield B implements.

The body was flexed, the left arm overlying the spine, the right arm almost under the body. A few ostrich eggshell beads were found in the pelvic region. The entire cranium was coated with lime and an earthy red ochre. Most of the bones, especially the long bones and the facial portion, have the lime crust. The pelvis shows a very considerable amount of ochre. A bored limpet shell lay beneath the pelvis, probably from the same string as the beads. The earth about the skeleton shows a considerable amount of red ochre mixed with the earth (Plate VII).

A peculiar displacement of the second upper left incisor was observed. It grew in the alveolar border immediately behind the canine. A similar, though less marked, displacement was observed on the right. Possibly to avoid similar congestion, the two first molars had been removed in the lower jaw, and had healed over.*

The left parietal bone and part of the left side of the occipital bone were crossed by a deep, straight crack, and wedged into the bone, suggesting that it was the cause of death, was a sharp, crude flake of white quartz. The inner face of the bone shows slight scaling, further suggesting that the blow was the cause of death. It is, however, possible that the crack was a result of intense external compression on the newly buried skull. The vertex of the skull shows signs of having been eaten into by disease, or perhaps by chemical action after death.

Grave XVI.—Depth 106 inches. Depth of gravestone 100 inches. Cave rear 30 inches. Skull on D/E. A child a few years old. Lay on left side, head to south, facing west, flexed. The grave is slightly above Grave XV, but lies on the basic cave sand. Ostrich eggshell fragments associated with slight scratchings on inner face. Whole skeleton buried in ochre. No ornaments.

Grave XVII.—Depth 57 inches, lay within Column I and under the overhang of the buttress between the Shelter and Inner Cave. The body

* See Goodwin, A. J. H., "Abnormal Dentition of a Bushman Skull," Trans. Roy. Soc. S. Afr., vol. xxiii, p. 3, 1935. Minutes of Proceedings, p. iii.

had been buried into the midden, and indications strongly suggest that the grave is Early Wilton. The shell of a water-tortoise covered the left arm. One or two spoon-like fragments of nacre were found in the grave.

The skeleton lay on its right side, head to north, facing west. Excavation of this skeleton was undertaken by Miss Mary Nicol, who was visiting the site (Plate VIII, C).

Fragments of an earlier skeleton (XVIII) were partly used as infilling to this grave. Possibly the same individual as that disturbed by Grave VII.

Relation of Grave Numbers to Skeletal Material.

	Adult.		Infant.	
	Skull.	Limb-bones.	Skull.	Limb-bones.
Grave I	1	1		
Grave II	2	2		
Grave III	3	3	(0) (not described, too fragmentary)	
Grave IV	No material received			
Grave V	5	5	(0)	(0)
Grave VI	6 A	6 A		
			6 *a*	
			6 *b* (E)	6 *b* (E)
			6 *d* (L)	6 *d* (L)
				(P)
				(D)
				(F)
				(J)
				(K)
Grave VII	..	7	..	7
Grave VIII	8 *b*	8, 8		
Grave IX	..	..	9	9 (G)
			9 A	9 A (H)
Grave X	..	..	..	(B)
Grave XI	No material received			
Grave XII	..	..	12	
Grave XIII	13	13		
Grave XIV	..	14		
Graves XV and XVI	15	15		
Grave XVII	No material received			
Grave XVIII	..	18		

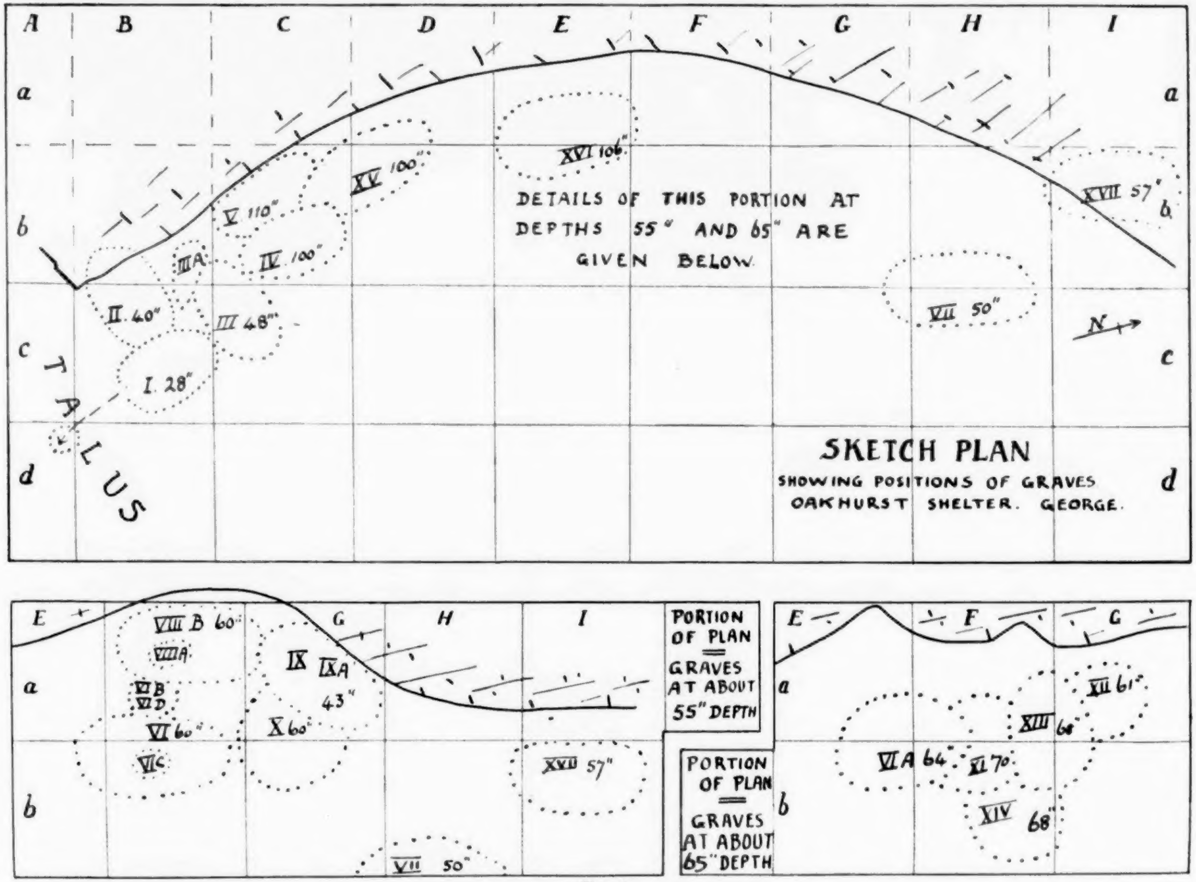
SKETCH PLAN
SHOWING POSITIONS OF GRAVES
OAKHURST SHELTER. GEORGE.
DETAILS OF THIS PORTION AT DEPTHS 55" AND 65" ARE GIVEN BELOW.
TALUS
PORTION OF PLAN = GRAVES AT ABOUT 55" DEPTH
PORTION OF PLAN = GRAVES AT ABOUT 65" DEPTH
A B C D E F G H I
a b c d
N
I. 28"
II. 40"
III 48"
IIIA
IV. 100"
V 110"
XV 100"
XVI 106"
XVII 57"
VII 50"
VIII B 60"
VIIIA
VIB
VID
VI 60"
VIC
IX
IXA
43"
X 60"
VIA 64
XI 70
XII 61
XIII 68
XIV 68"

Fig. 4.

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A

B

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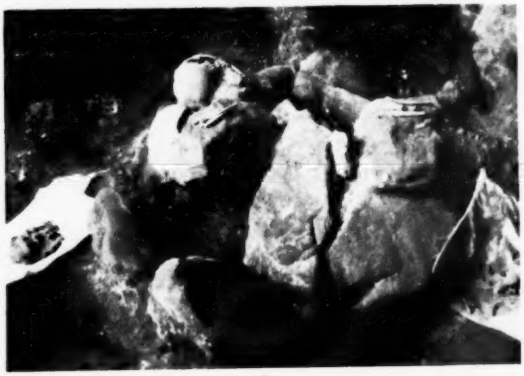
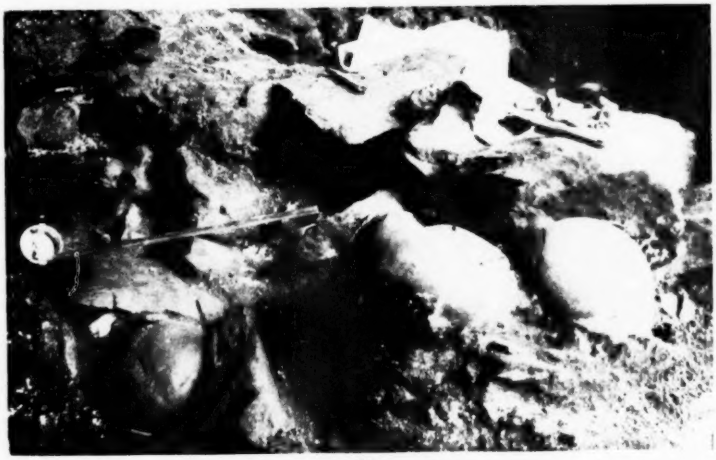


A



B

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ARCHAEOLOGY OF THE OAKHURST SHELTER, GEORGE.

Part III. The Cave-Dwellers.

By Professor M. R. Drennan,
From the Anatomy Department, University of Cape Town.

(With six Text-figures.)

(Read April 21, 1937.)

In the course of excavations that have been carried on since 1932 in the Oakhurst cave, near George, an extensive collection of human remains has been made. Mr. A. J. H. Goodwin has directed and taken an active part in this important undertaking, and he has very kindly submitted all the human skeletal material to me for restoration and examination. For details of the excavation and of the associated cultures reference should be made to Mr. Goodwin's own reports.

This paper and the succeeding one embody the results of my investigation of the various skeletons discovered in the cave, and, as these include not only a number of Bushmen of a special type, but also, for the first time, a good series of infants of different ages, their study has seemed to me to be one of special value and significance.

A mere glance at the adult specimens is sufficient to satisfy anyone familiar with Bushman material that the great majority of them did not belong to members of the usual Bushman population of the more superficial strata of such caves, but to a taller and much more robust group of people. All of them, however, show a sufficient number of Bushman characteristics to make it clear that this group were members of the Bushman race, using this latter term to include not only the small modern Bushman, but also a number of different types of pre-Bushmen, some of these of considerable size. A few of the present skeletons, especially the females, do, in fact, approximate closely to the ordinary Bushman, so that the population of this cave was a somewhat mixed one, but I hope to show that it is not really so heterogeneous as it appears at first sight to be.

Most of the burials thus far exhumed lay at a depth of less than 6 feet, and there was considerable disturbance of the graves by successive burials, so that there is no very definite stratigraphic sequence. It is obvious

that, up to this limited depth of 6 feet from the surface, more recent burials might be even deeper than earlier ones. I have therefore thought it better to regard them all as having been members of a single tribal group that must have inhabited this cave for quite a considerable time prior to the European occupation of the country. The measurements show that they are quite as homogeneous as were the modern tribe of Bushmen described by Slome (1929).

The relatively recent age and the comparatively large stature of these Bushman types suggest at once that these people might have been members of a Hottentot tribe that had made use of this cave as a shelter and a burial-ground. For we know that the Hottentot, although his physical type has not yet been clearly defined, was a contemporary of the modern Bushman, whom he resembled in many respects, except that he was taller and had a decidedly bigger head. It is quite certain also that considerable intermingling took place between Hottentots and Bushmen, and this could account for the mixture of types found in the cave.

Recent excavations in other caves, however, have shown that these were inhabited by various grades of Bushman, some of them being taller and more robust than modern Bushmen. Thus Meiring (1935) has shown that the series of skulls unearthed by Professor T. F. Dreyer at the early Wilton culture level in the Matjes River cave were big-headed and relatively tall pre-Bushman types, which Keith has described as Boskop types.

In the present excavation there was plenty of evidence of the Wilton culture, but it obviously develops into a later phase than that encountered at Matjes River, because in this Oakhurst shelter there is an abundance of late pottery, whereas sherds are entirely absent from the Wilton stratum of the Matjes River cave. It would appear, then, that some of the present group of skeletons belong to a later Bushman period. Nevertheless, these Oakhurst cave-dwellers do resemble the "Wilton race" from Matjes River, but they are not quite so tall, and they have somewhat smaller crania and longer faces.

In his endeavour to explain the sequence of types in the Matjes River cave, Sir Arthur Keith (1933) considered that it was quite "feasible to assume not a sudden replacement of stocks, but the local evolutionary transformation of the same stock through a long period of time." On this hypothesis one might interpret this Oakhurst tribe as modified linear successors of Meiring's Wilton race, the presence of the modern Bushman element indicating some stunting due to local conditions and a transition from a larger to a smaller type. On the other hand, this group might be the result of a cross between the Wilton race and small Bushman types already evolved elsewhere.

The very close resemblance between these Oakhurst people and more modern Hottentots, which will be brought out in this paper, is a fact of very great significance. It offers a somewhat new, but a perfectly feasible, explanation of the vexed question of the origin of the Hottentot. He is quite conceivably a lineal descendant of the "Wilton race," and in the present cave we see him fully evolved physically, before he had acquired the special Hottentot culture, of which there is practically no evidence in this cave except in Schofield's analysis of the pottery. The Hottentot might thus have got his increased stature and larger head, not from a relatively modern crossing between Bushman and Bantu, as is sometimes thought, but from an older stock such as the Boskop type. In this connection it is interesting to recall that Shrubsall (1907), who was one of the first to study the Hottentot, and who pointed out that in many ways the Hottentot was intermediate between the Bushman and the Bantu, was very sceptical about a hybrid origin, because of the great uniformity of the Hottentot type, which argued for a very ancient origin.

In any case the Hottentot is far too light in the colour of his skin, in my opinion, to be a cross between the Bushman and the Bantu. As regards the so-called Hamitic element in the Hottentot, this also could be supplied by the "Wilton race," for according to Meiring his "Wilton race" is not strictly a local one but has strong affinities with late Palaeolithic man in Europe and North Africa, from which region he considered he was a migrant. It is not necessary, however, to pin one's faith to any particular migration ; the affinity between the early South African types in general and Aurignacian man, both physically and culturally, is now generally admitted.

The affinity between Boskop man and Cro-Magnon man, which Haughton (1917) established, is particularly interesting in the present connection, because, when Keith (1933) was in search of material with which to compare a Boskopoid skull from a stratum in the Matjes River cave beneath the Wilton, it was to the collection of pure Hottentot skulls in the Museum of the Royal College of Surgeons that he resorted. The idea therefore of linking the Hottentot backward through Wilton types to Boskop man is not entirely my own, and it is not altogether new, as in 1925 I classified a big-headed Boskopoid type from the dissecting-room as a type of Hottentot.

Nor is this the first time that the suggestion has been made that Hottentot types might have been responsible for cultures hitherto regarded as strictly Bushman. In his "Contribution to the Craniology of the Yellow-skinned Races of South Africa," Broom (1923) gave it as his opinion that skulls from the Western coastal region of South Africa, which Shrubsall had classified as Strandloopers, were in reality Hottentots. That is to say, there is some evidence that the "kitchen-midden" cultures, with which

the purest type of Bushman has usually been associated, was in certain regions at least practised by a Hottentot type. These cultures have a number of neolithic facets, and might quite easily have linked up with the later more pastoral habits of the same people.

The Adult Limb Bones.

It is the appearance of the long bones of these individuals that so definitely places them in a different category from the ordinary Bushman. The great majority of the bones are relatively long and robust, and quite different from the diminutive bones of the typical Bushman.

The length of the various bones is given in Table I, taking the measurement from whichever limb was available, or the average length of both limbs when bones from both sides were present. The great majority of the bones approximate to the Hottentot rather than to the Bushman in dimensions. This is true of all the male skeletons and of two of the females, but the other two females are typically Bushman.

In Table II the average length of the humerus, radius, femur and tibia is given according to sex, the figures in brackets referring to the number of bones measured. In this table I have given Slome's (1929) results for the males and females of a Bushman tribe, and the contrast between the Oakhurst tribe and this Bushman tribe is very striking. In the next three columns I have compared the average for both sexes of the Oakhurst tribe with Slome's Bushmen and with Vermooten's measurements of a number of Hottentots of both sexes (Martin, 1926). This leaves no doubt as to the Hottentot affinity of the Oakhurst cave-dwellers. In the last column the measurements of a few skeletons housed in my own department that I have classified as Hottentots are given, because it shows the greater stature to which I think the true Hottentot occasionally attains.

As regards the relative length of the limbs and limb segments, there does not appear to be any very significant difference between Bushmen and Hottentots. The relatively long tibia of Vermooten's Hottentot group, as indicated by the high tibio-femoral index of 87, suggests that there may be a tendency for the Hottentot to differ from the Bushman in this direction, and in this connection the Oakhurst people tend to go with him rather than with the Bushman.

In Table I, I have given the stature of each individual, as calculated by using Manouvrier's tables and by means of Pearson's regression formulae. It is interesting to see how closely the results arrived at by using these two very different methods agree with one another. In the following table I have compared the average stature of males and females in the Oakhurst tribe, calculated from Pearson's formulae, with similarly calculated data

for Slome's Bushman tribe, and with Shrubsall's results for Cape Bushmen and Hottentots:—

	Oakhurst Tribe (Drennan).	Bushman Tribe (Slome).	Cape Bushmen (Shrubsall).	Hottentots (Shrubsall).
Males (8)	1631	1575	1565	1611
Females (4)	1525	1489	1422	1491

It has not been possible for me to make a comprehensive comparison between this Oakhurst material and Meiring's "Wilton material" from the Matjes River cave, as this author gives the measurements of the long bones of only one individual, and that the smallest of the males. This Wilton skeleton No. 4 had a humerus measuring 304 mm., a radius 250 mm., a femur 427 mm., and a tibia with a maximum length of 376 mm. Meiring estimates the height of this Wilton man as being 5 feet 6½ inches, but I do not think he could have been more than 5 feet 4 inches, the average height of the Oakhurst males.

This individual has a relatively long radius, the radio-humeral index being 82. This strongly marked negroid feature tends to belie Meiring's contention that his "Wilton group" have little or no relationship to South African types but align themselves with the Cro-Magnons. The same is true of the relatively long tibia of this individual, the tibio-femoral index being the high one of 88. This also is negroid, and to some extent, as I have already pointed out, a Hottentot feature. The humero-femoral index of 71 and the intermembral index of 69 are quite close to the Bushman and Hottentot ratios. As far as the measurements of the limb bones of this one individual show, there does not appear, then, to be a very great difference between the "Wilton group" from Matjes River and the Oakhurst population.

The Adult Skulls.

A detailed survey of the individual skulls is presented in Table III, but there are unfortunately many blanks in the columns due to the poor state of preservation of much of the material. In figs. 1–6 three of the male and three female skulls are illustrated by projection drawings.

The Males.—In Table IV, I have compared the males from Oakhurst with a group of male Bushmen and Hottentots studied by Shrubsall (1907), with male Bushmen and Hottentot types in my own collection, and with male Hottentots and Bushmen studied by Broom (1923).

Shrubsall's data is the product of the analysis of a group of 29 Bushman

and 19 Hottentot skulls, and although Broom has expressed severe criticism about the classification of these specimens, in my opinion their relatively large numbers discount these possible errors to a very considerable extent.

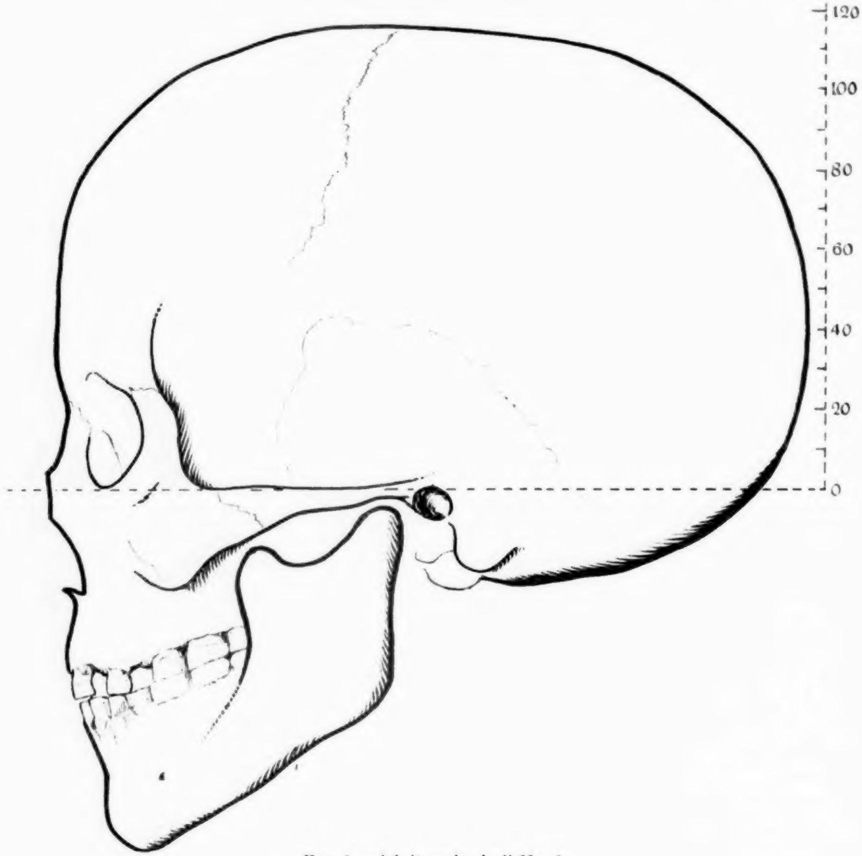

FIG. 1.—Adult male skull No. 1.

Broom claims that his own Upington skulls are the best Hottentot specimens that he has been able to examine, and he has some justification for his contention inasmuch as his material was excavated from typical Hottentot graves. But Broom discards two of the Upington specimens exhumed, because they do not conform to the other four, so that there is something arbitrary in his own classification. Besides some of his Korana material

is probably from historical graves and therefore of doubtful pedigree. Nevertheless, I consider that the data from his male specimens, from the Upington graves and from his Korana group, constitutes a very good criterion of the morphology of the Hottentot type of skull.

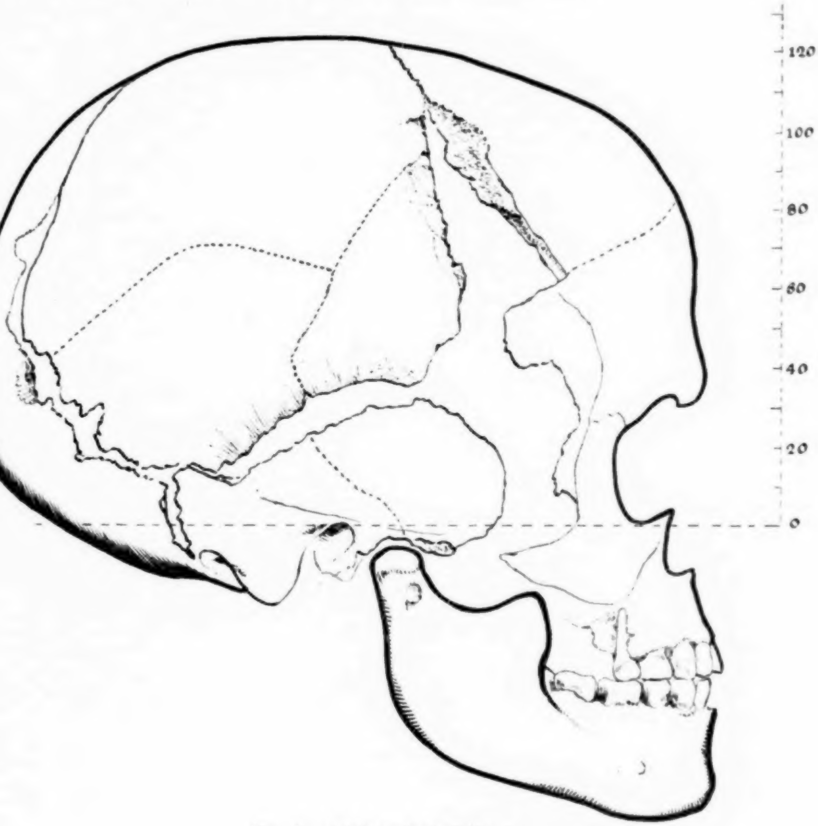

Fig. 2.—Adult male skull No. 2.

I do not agree, however, with Broom's other contention that his Cape Colony and Griqualand West Bushmen are "probably the purest Bushman remains that have yet been discovered." I need only refer to the great length of their faces, as indicated by their high facial index of 55. This character is almost sufficient, in my opinion, to exclude them altogether from the Bushman category, because a great mass of evidence has shown

that the typical Bushman is short faced. Broom admits that this group of his is not stunted, but consists of well-developed and powerfully built types. This is in agreement with one of Shrubsall's conclusions that the Inland Bushman approximates the Hottentot to a considerable extent,

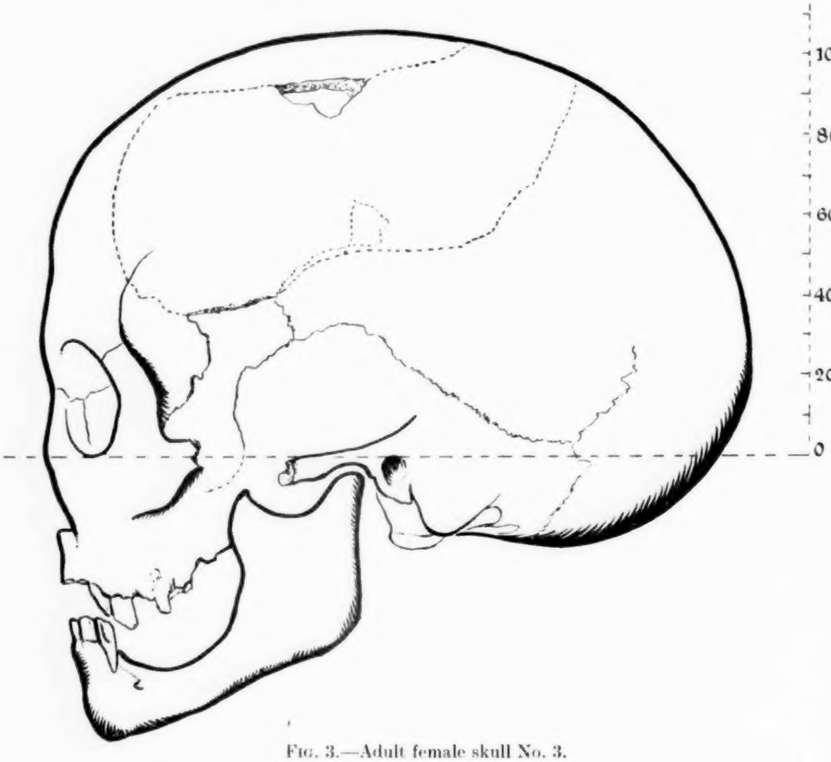

FIG. 3.—Adult female skull No. 3.

and I think this statement applies to Broom's Cape Colony and Griqualand Bushmen. On the other hand, Broom's Kalahari Bushmen seem to me to be very pure, and I would have used this group of his for comparison in preference to his other group, but the Kalahari specimens have not been classified with regard to sex.

With the above-mentioned qualifications my Table IV is as good a standard with which to compare Bushman and Hottentot skulls as can be set up in the present state of our knowledge of these two races. Like every other anthropologist, I have found great difficulty in the past in

isolating the two types. This is not to be wondered at in view of the great limitations in available material, and when one considers that they are probably just relatively recent and badly differentiated branches of a common stock, not isolated from one another by any geographical barrier

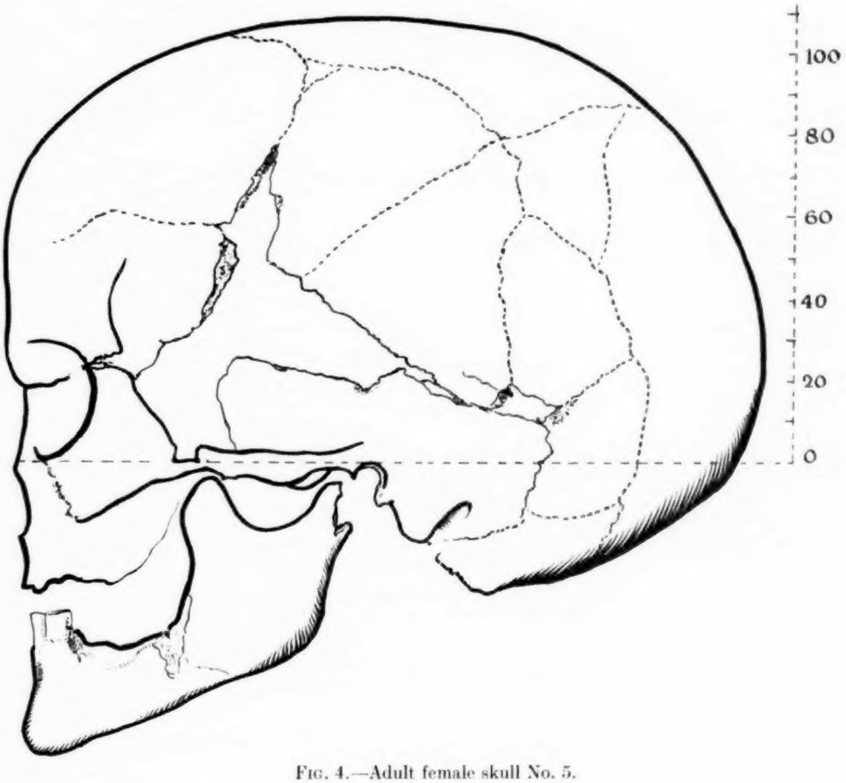

FIG. 4.—Adult female skull No. 5.

but rather thrown into each other's way to the encouragement of miscegenation.

What, then, are the special features of the Hottentot skull? As befits a member of the Khoisan (Bushman) race, in the wide sense of this term, it shows many of the general features which characterise the Bushman skull, and I need not recount these for my present purpose. The Hottentot skull tends, however, especially in the case of the male, to be anything from 5 to 15 or more millimetres longer than the Bushman skull. On the

other hand, there is no proportionate increase of breadth accompanying the increase in length, and often there is an absolute diminution in the breadth. As a result the greater majority of Hottentots are dolichocephalic

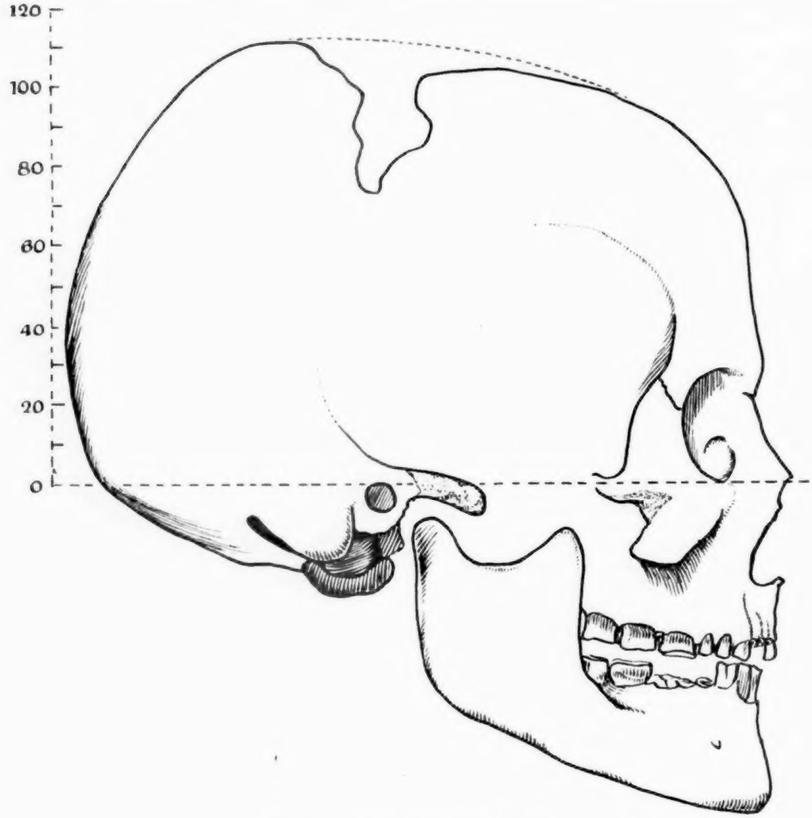

Fig. 5a.—Adult male skull No. 8b.

or even hyperdolichocephalic, whereas a much smaller proportion of Bushmen are dolichocephalic, the majority being mesaticephalic. As a result the shape of the calvaria tends to change from the broad sharply pentagonoid shape of the typical Bushman to a more elongated oval, but still slightly pentagonoid, form in the Hottentot.

The vault of the Hottentot skull, as measured by the basion-bregma dimension, is always definitely higher than that of the Bushman. In

comparing the length-height ratio in Hottentots and Bushmen by means of an index there is very little difference between them, because the increased height of the Hottentot skull is masked by the increased length

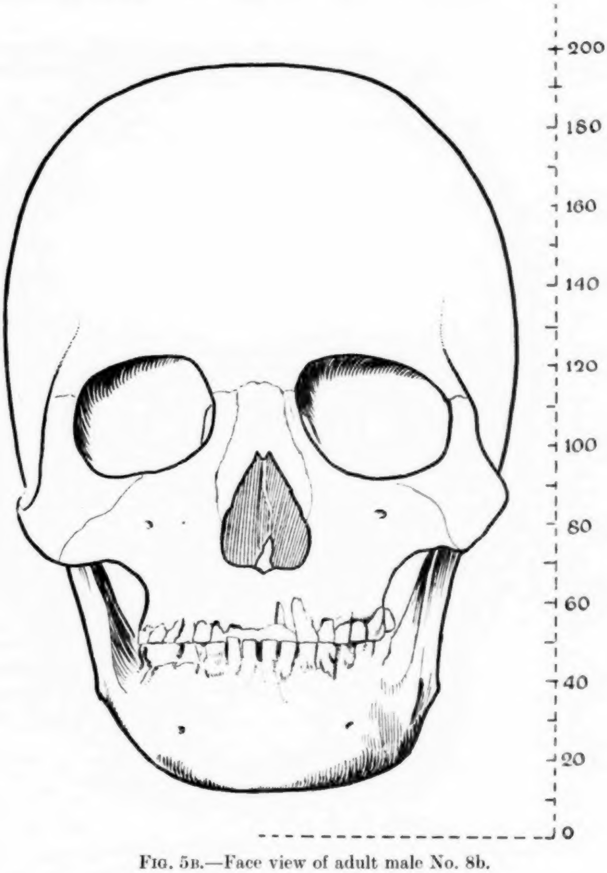

FIG. 5B.—Face view of adult male No. 8b.

of his skull. On the other hand, the breadth-height index, which is usually much higher in the Hottentot than in the Bushman, brings out the difference between the two races very markedly. Shrubsall was the first to point out that "this character more than any other serves to distinguish Hottentot from Bushman crania," and Broom in a later publication stressed the specificity of this feature.

The width of the face in the Hottentot, as measured by the maximum bizygomatic diameter, is only slightly greater than that of the Bushman, in keeping with the general narrowness of the Hottentot cranium. The length of the face, on the other hand, as measured by the nasion-prosthion

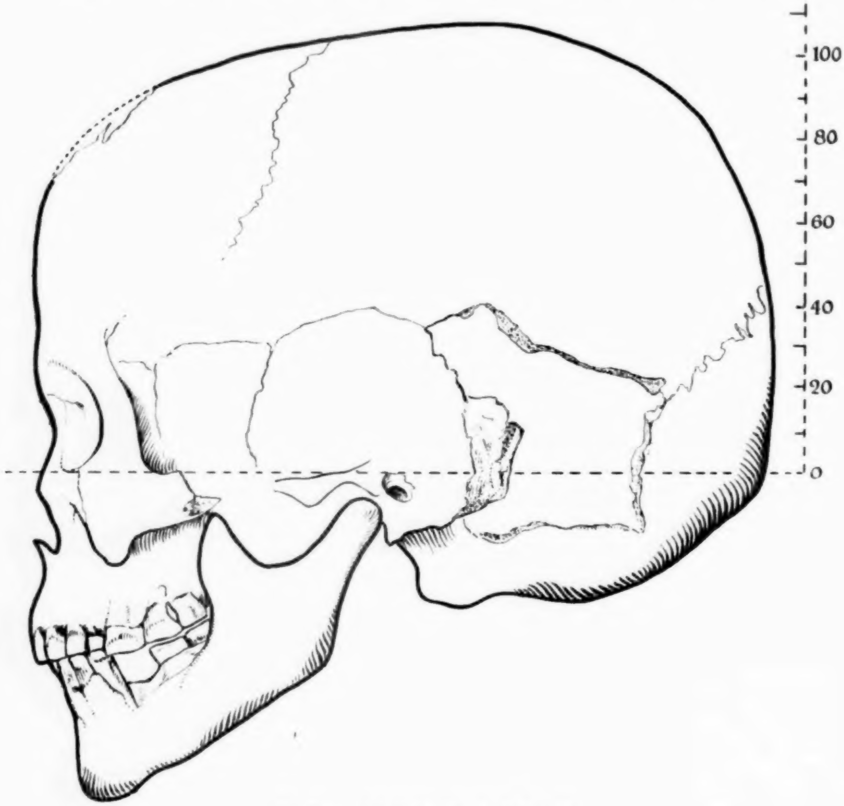

FIG. 6A.—Adult female skull No. 13.

dimension, is very definitely increased in the Hottentot. The upper facial index therefore shows a considerable degree of leptoprosopy in the case of the Hottentot, whereas the Bushman face is shorter and broader, being very frequently chamaeprosopic. When the depth of the symphysis menti of the robust Hottentot mandible is added to complete the facial length, the total facial index is also considerably higher in the Hottentot than it is in the Bushman. The face (nasion-prosthion) of the Hottentot is also

long in relationship to the length of the base of the skull (basion-nasion), and this is well brought out by what I have called the "subgnathic" index. The increase in this ratio is all the more significant, seeing that it manifests

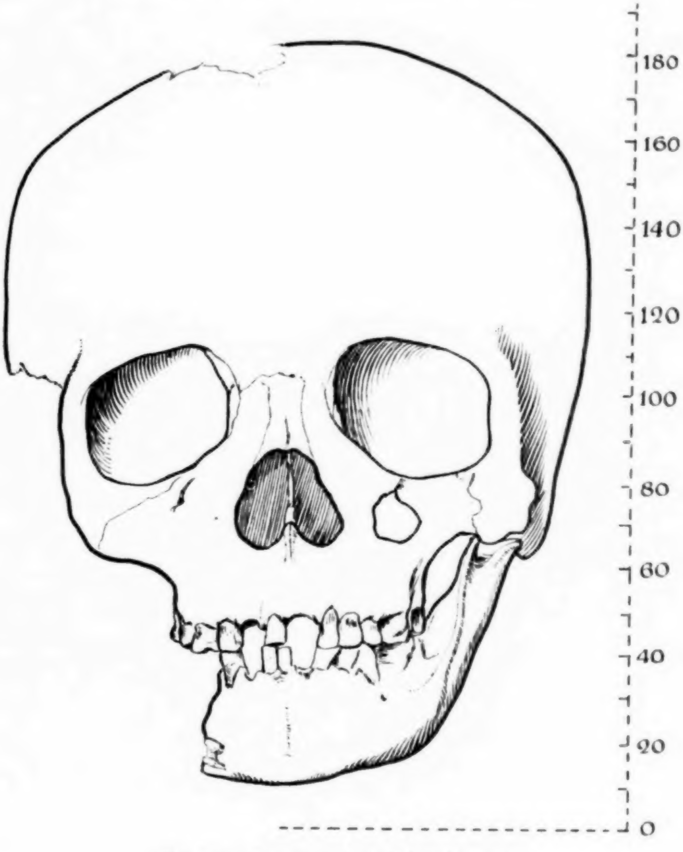

FIG. 6B.—Face view of adult female No. 13.

itself despite the increased length of the base of the elongated Hottentot skull. This downward extension of the face gives rise to the appearance of prognathism, but it is almost entirely a "subgnathism," because there is very little greater forward projection, as determined by the gnathic index, in the Hottentot than in the Bushman.

My findings do not support the statement made by Shrubsall that

"the Hottentots have much higher more rounded orbits, approximating to those of the Bantu-speaking negroes." On the contrary, I have found that the orbital index is usually much lower in the Hottentot than in the Bushman, and this view is corroborated by the results of several other workers. This relatively low orbit is, moreover, what one would expect to find in the Hottentot, seeing that he is definitely less infantile than the Bushman in practically every other respect.

On the whole there is very little difference in the proportions of the nasal aperture in Hottentots and Bushmen, both being markedly platyrrhine. As regards the degree, however, there appears to be a considerable conflict in the results of different observers, which subsequent researches may clear up.

The mandible of the Hottentot is a very distinctive bone, and I regret not being able to submit more comparative data regarding it. It is much more massive than in the Bushman, and very much longer, but it is not much wider in keeping with the general narrowness of the Hottentot skull. The mandibular index is therefore much higher in the Hottentots than in the Bushman. The ramus of the Hottentot mandible is also more robust, and even wider relative to its height than the Bushman ramus.

Having thus defined the physical features of these two components of the Bushman race, I am in a position to determine with which of them the Oakhurst people have the closest affinity. A mere glance at Table IV is sufficient to demonstrate that the Oakhurst males present all the features I have indicated as being characteristic of the Hottentot. In certain features, such as length of face, they have the Hottentot features to a pronounced degree. There is no escape therefore from the conclusion that these people belonged to the same stock as the more modern Hottentot.

The Females.—The problem presented by the females is not such a straightforward one as that just dealt with in connection with the males. With one exception, namely, No. 5, which is a big-headed female, the female skulls are to all intents and purposes Bushman types. This one specimen, it is to be noted, was found at a depth of about 100 inches, and is relatable to the lowest inhabited layer in the shelter, the Smithfield B deposit. It is therefore culturally early so far as this shelter is concerned.

This disharmony between males and females is not a new phenomenon, however, in connection with the study of Hottentot types, as can be shown by a study of Table V. In this table I have given the average measurements of the three somewhat similar female types, ignoring the high figures of No. 5 as being likely to give rise to misleading results in such a small sample. In the adjoining column I have given Shrubsall's measurements taken from a good collection of female Hottentot and Bushman skulls. It is obvious that these two groups are identical, but Shrubsall

went to elaborate mathematical pains to prove it before coming to the conclusion that "In comparing female crania, owing to the small number of examples available for any of these groups, no differences which could not be simply explained by chance are found between either Bushmen, Strandloopers, or Hottentots."

The same phenomenon is found in the next column, in which I give corresponding data for female Hottentots and Bushmen collected by Hrdlička (1928) for his review of world races. The value of these figures lies in the fact that they have been gathered from material in several different institutions by one individual using the same technique.

In the last two columns I set out averages from Broom's data for Hottentot and Bushman types. Broom's Bushman females seem to be even more robust than his Bushman males, as the average of each of the cranial measurements is the same for both sexes, but the female faces are definitely more refined. This approximation of the female Bushman skull to that of the male is decidedly closer than the great majority of other workers have found it to be, but it is generally conceded that the differences between the male and female Bushman skulls are never absolute.

As regards Broom's Hottentot females, these have relatively enormous heads and are only a fraction smaller in both brain-case and jaw than his male group. I have come to the conclusion therefore that, if these big skulls are to be regarded as having belonged to pure Hottentots, then they are a Boskopoid type, and quite distinct from that other race to which the majority of authors have applied the term Hottentot. For there is no doubt that there was another large branch of the Bushman race with a relatively taller stature than the Bushman and a less exaggerated type of head than Broom postulates for the Hottentot race.

In this connection it is worth mentioning that Brink (1924), in his excellent "Genetic Study on the Osteology of the Griquas" (Hottentots), proved conclusively, from skeletal material that he had exhumed from old graves, that the increase in the height of their skulls and their reduced prognathism was the result of a European admixture.

I find it impossible therefore at this stage to dispense with Shrubsall's findings, which are based on material regarding which he had no doubt good ethnological and physical grounds for believing that they were members of the Hottentot race. Nor am I alarmed at the extraordinary sexual difference that has been shown by Shrubsall to exist in his Hottentot types, and which occurs again in the Oakhurst tribe. Although the difference is probably greater than occurs in any other race, and the difference is not only a matter of size but extends to type as well, because all the female Hottentots so far described have Bushman features, nevertheless there is genetic precedent for a marked difference between the

two sexes. It occurs in the anthropoids, especially in the gorilla, and it is found much closer to us in Peking man, where the difference between males and females is so great that Weidenreich (1936) has still to defend his thesis that the smaller types are females and not members of another species. The remarkable thing therefore is that sex differences have become so fine in so many of the human races, not that they should manifest themselves to an extreme degree in this primitive group.

In view of the above it seems possible to associate the Oakhurst females with the males. All of their skull measurements harmonise with such data as I have admitted as a test of their standing in relationship to the Hottentot type. Their average stature of 5 feet 2 inches, which exceeds that of the Hottentot female by 1 inch and that of the Bushman by 2 or 3 inches, is still more suggestive of a Hottentot affinity.

The average cranial capacity of the Oakhurst tribe is 1307 c.c., which is a figure considerably in excess of the average Bushman capacity of about 1250 c.c. The following table shows their Hottentot affinity in this important direction:—

	Oakhurst Tribe (Drennan).	Cape Bushmen (Shrubsall).	Hottentots (Shrubsall).
Males . . .	1353	1260	1380
Females . .	1233	1200	1280

Thus far I have been considering the relationship between the Oakhurst people and their contemporaries and successors. It is now worth while having a cursory look at some of the earlier cave-dwellers to see if there is any relationship between Hottentot types, such as the Oakhurst people were, and the earlier "Wilton people," for example. I have already referred to the fact that Sir Arthur Keith considered at least one of the pre-Wilton Boskopoid skulls from the Matjes River cave to be Hottentot in type.

Meiring, on the other hand, has tried to prove that his "Wilton group" have no relationship with later Hottentot types, but I do not agree with his conclusion. His "Wilton skulls" have an average maximum length of 191 mm., a breadth of 141 mm., and a basi-bregmatic height of 136 mm. They are therefore very large skulls with the dolichocephalic index of 74, and their height-breadth index is the high one of 96. Meiring admits their general Hottentot resemblance on inspection, and their proportions also show that they had the special Hottentot shape. These skulls have brow-ridges developed to about the same extent as in the Korana Hottentots,

and they have a robust mandible similar in shape to the lower jaw, which I have already described as being characteristic of the Hottentot.

In only one respect do the "Wilton types" differ materially from the Hottentots, namely, in having definitely shorter faces, but this is not the most critical feature of the Hottentots, and it is certainly not sufficient in itself to discount all the other Hottentot affinities. I am of opinion therefore that the immediate ancestry of the Hottentot has to be sought, not in the North, from which direction he is generally supposed to have migrated at a relatively recent date, but in our own caves and from types that probably had some connection with Northern peoples in much remoter times.

Summary.

This paper contains the results of a study of the adult skeletons disinterred by Mr. A. J. H. Goodwin in the course of his excavations at the Oakhurst cave. Owing to the fact that these remains are from graves, which naturally have upset the general stratigraphy to a considerable extent, I have thought it inadvisable at this stage to discuss these skeletons in terms of their cultural associations. The present work is therefore a somewhat independent effort to determine the race to which these people belonged or were most closely related.

At an early stage in the investigation it became clear to me that these cave-dwellers were taller, more robust, and had bigger heads than the ordinary Bushman. In this respect they resemble a type to which the term Hottentot has frequently been applied. As this latter type has hitherto not been too clearly defined, I have felt it necessary to devote a considerable part of my report to a general discussion of this Hottentot problem. With this object in view I have collected such data as I considered relevant from previous workers for convenience of comparison. Detailed measurements of all the available skulls and limb-bones are also set out in the tabular appendix to this report.

The main conclusion to which I have been led by this study of these Oakhurst cave-dwellers is that it is to the Boskop type in our own South African caves, and not to relatively modern migrations and hybridisations that we must look for the immediate ancestry of the Hottentot.

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APPENDIX.

TABLE I.

Excavation No.	1.	2.	3.	5.	6 A.	7.	8.	8.	13.	14.	15.	18.
Sex	♂	♂	♀	♀	♂	♂	♂	♂	♀	♂	♀	♂
Clavicle	155	134	133	..	..	..	152	147	..	..	..	135
Humerus	306	315	291	..	315	..	301	..	..	..	268	280
Radius	235	245	226	221	244	228	249	242	212	..	..	..
Innominate breadth	143	147	128	134	..	..	146	..	..	137	119	..
Innominate height	194	187	171	184	..	..	192	..	..	193	169	..
Femur (oblique)	425	446	410	412	..	..	436	..	..	429	377	428
Tibia (standard)	371	363	..	344	345	349	359	..	..	354	326	362
Calcaneus length	74	72	66	68	67	72	..	..	..	..	..	73
Calcaneus breadth	46	39	38	40	38	41	..	..	..	..	..	44
Talus length	45	48	45	44	43	51	..	..	..	..	..	52
Talus breadth	40	38	35	35	35	39	..	..	..	..	..	43
Innominate index	74	79	75	73	..	..	76	..	..	71	70	..
Radio-humeral index	77	78	78	..	77	..	83	..	..	..	..	..
Tibio-femoral index	87	81	..	83	..	..	82	..	..	83	86	85
Intermembral index	68	69	..	..	..	..	69	..	..	..	..	..
Stature (Manouvrier)	1620	1639	1560	1553	1620	1609	1623	1595?	1536?	1619	1478	1651
,, (Pearson)	1625	1645	1547	1546	1632	1610	1631	1651?	1521?	1624	1476	1632

TABLE II.

	Oakhurst Tribe.		Bushman Tribe (Slome).		Oak-hurst Tribe.	Bushman Tribe (Slome).	Hottentots (Ver-mooten).	Hottentots (Drennan).
	Male.	Female.	Male.	Female.	♂ and ♀.	♂ and ♀.	♂ and ♀.	♂.
Humerus	(5) 303	(2) 280	(12) 286	(16) 272	(7) 297	(33) 278	(7) 308	(4) 310
Radius	(6) 241	(3) 220	(12) 224	(12) 203	(9) 234	(26) 214	(6) 242	(3) 240
Femur	(5) 435	(3) 400	(14) 411	(25) 391	(8) 420	(43) 399	(6) 433	(4) 446
Tibia	(7) 358	(2) 335	(14) 337	(25) 321	(9) 353	(43) 328	(8) 375	(4) 370
Radio-humeral index	79	78	78	75	79	77	79	77
Tibio-femoral index	84	85	82	82	84	82	87	83
Humero-femoral index	69	71	70	70	70	70	72	70
Intermembral index	69	..	68	67	69	68	68	67

Table III.

Measurements of Adult Skulls.

Excavation No.	1.	2.	3.	5.	6 A.	8 *b*.	11.	13.	15.
Sex.	♂.	♂.	♀.	♀.	♂.	♂.	♂.	♀.	♀.
Maximum length .	188	184	176	190	184	176	..	178	174
,, breadth .	138	135	128	144	132	130	..	139	134
Basion-bregma height	132	..	123	..	..	..	..	131	124
Aur. height . .	114	120	104	108	..	109	..	106	108
Min. frontal diameter	98	..	..	..	..	93	..	..	96
Max. bizyg. diameter	126	..	108	..	..	129	..	110	112
,, bimastoid diam.	119	..	101	..	..	..	..	122	110
Nasion-prosthion .	70	..	54	..	..	66	..	58	54
Basion-prosthion .	96	..	84	..	..	101	..	98	82
Basion-nasion . .	101	..	93	..	..	102	..	101	88
Nasal breadth . .	27	..	29	..	..	26	..	26	23
,, height . .	51	..	40	..	..	50	..	42	38
Interorbital breadth .	29	..	23	..	..	28	..	26	25
Orbital height . .	32	..	29	..	..	32	..	31	29
,, breadth .	39	..	37	..	..	39	..	39	39
Nasion-menton height	115	..	88	..	..	108	..	96	93
Max.-alv. breadth .	62	..	58	..	..	63	..	57	53
,, length .	52	..	49	..	..	52	..	49	44
Sagittal arcs:									
Frontal . .	145	140	..	..	..	..	..	130	132
Parietal . .	150	120	..	..	..	..	..	130	130
Occipital . .	90	115	..	..		..	..	105	98
Total . .	385	375	..	..	..	..	..	365	360
Transverse arc . .	300	..	..	..	..	..	..	300	295
Horizontal circumf. .	530	510	..	538	..	480	..	510	495
Cranial capacity .	1403	1410	1195	1389	..	1247	..	1290	1214
Cranial index . .	73	73	73	76	72	74	..	78	77
Mean height index .	81	..	81	..	..	..	..	83	81
Altitudinal index .	70	..	70	..	..	..	..	74	71
Height-breadth index	96	..	96	..	..	..	..	94	93
Upper facial index .	56	..	50	..	..	51	..	53	48
Nasal index . .	53	..	73	..	..	52	..	62	61
Orbital index . .	82	..	78	..	..	82	..	80	74
Max.-alv. index .	119	..	118	..	..	121	..	119	120
Cranial module. .	153	..	142	..	..	..	..	149	144
Total facial index .	93	..	82	..	..	84	..	87	83
Gnathic index . .	95	..	90	..	..	99	..	97	93

TABLE III—*continued.*

Excavation No.	1.	2.	3.	5.	6 A.	8 *b*.	11.	13.	15.
Sex.	♂.	♂.	♀.	♀.	♂.	♂.	♂.	♀.	♀.
Subgnathic index	69	..	58	..	..	65	..	57	61
Frontal index	38	37	..	..	..	..	..	36	37
Parietal index	39	32	..	..	..	..	..	36	36
Occipital index	23	31	..	..	..	..	..	28	27
Mandibular length	107	102	91	105	..	112	104	100	..
,, breadth	109	113	108	108	..	118	107	116	..
,, index	98	90	84	97	..	95	97	86	..
Ramus breadth	35	38	28	35	..	41	40	31	29
,, height	40	39	35	34	..	37	37	31	31
,, index	88	98	80	97	..	111	108	100	94

TABLE IV.

Males.

	Oakhurst Tribe (4).	Hottentots (Shrubsall) (19).	Bushmen (Shrubsall) (29).	Hottentot Types (Drennan) (6).	Bushmen (Drennan) (6).	Hottentots (Broom) (7).	Bushmen (Broom) (4).
Cranium.							
Maximum length	183	183	179	192	178	193	182
,, breadth	134	133	135	140	138	133	138
Basion-bregma height	132	131	126	132	125	132	126
Length-breadth index	73	73	75	73	78	69	76
Length-height index	70	72	70	69	70	68	69
Breadth-height index	96	98	93	94	91	99	91
Face.							
Maximum bizyg. diameter	128	126	121	130	124	126	128
Nasion-prosthion	68	66	60	73	65	68	70
Basion-prosthion	99	100	95	102	96	100	94
Basion-nasion	102	98	95	102	97	104	97
Upper facial index	54	52	50	53	52	54	55
Gnathic index	97	102	100	100	99	96	97
Subgnathic index	67	67	63	72	67	65	72
Nasal breadth	27	26	26	30	26	27	27
,, height	51	46	43	51	45	45	47
,, index	53	57	60	59	58	60	57

TABLE IV—*continued.*

	Oakhurst Tribe (4).	Hottentots (Shrubsall) (19).	Bushmen (Shrubsall) (29).	Hottentot Types (Drennan) (6).	Bushmen (Drennan) (6).	Hottentots (Broom) (7).	Bushmen (Broom) (4).
Mandible.							
Mandibular length . .	106	..	..	107	97	..	..
,, breadth .	111	..	..	114	110	..	..
,, index . .	95	..	..	94	88	..	..
Ramus breadth . .	39	..	..	39	36	..	..
,, height . .	38	..	..	44	42	..	..
,, index . .	103	..	..	89	86	..	..

TABLE V.

Females.

	Oakhurst Tribe (3).	Hottentots (Shrubsall) (11).	Bushmen (Shrubsall) (14).	Hottentots (Hrdlička) (4).	Bushmen (Hrdlička) (6).	Hottentots (Broom) (8).	Bushmen (Broom) (5).
Cranium.							
Maximum length . .	176	177	175	176	174	189	182
,, breadth. .	133	132	133	135	131	129	138
Basion-bregma height .	126	126	124	123	123	132	126
Length-breadth index .	76	75	76	76	75	68	76
Length-height index .	72	71	71	70	71	70	69
Breadth-height index , .	95	95	93	91	94	102	91
Face.							
Maximum bizyg. diameter	110	119	116	125	119	125	120
Nasion-prosthion . .	55	61	60	66	58	67	62
Basion-prosthion . .	88	95	92	93	94	98	91
Basion-nasion . .	94	95	93	94	95	102	96
Upper facial index. .	50	51	52	53	49	54	52
Gnathic index . .	93	100	99	99	99	96	95
Subgnathic index . .	59	64	65	70	61	66	65
Nasal breadth . .	26	25	?	26	25	28	24
,, height . .	40	43	43	48	42	45	43
,, index . . .	65	58	?	55	60	62	56

ARCHAEOLOGY OF THE OAKHURST SHELTER, GEORGE.

Part IV. The Children of the Cave-Dwellers.

By Professor M. R. Drennan.

(With six Text-figures.)

(Read April 21, 1937.)

It is not often that such a good series of infant skeletons as Mr. Goodwin has fortunately retrieved from the Oakhurst cave is available for anthropological study. This is not because of any scarcity of infant remains in prehistoric sites, for infant mortality has probably been as high in other places as it apparently has been in the Oakhurst cave. It is the great readiness with which the delicate and fragile bones of infants disintegrate that makes their remains so scarce. The skull bones, for example, are as thin as paper in certain regions, and even the more robust cranial bones tend to fall apart. As a result the casual collector usually passes them by in favour of less delicate trophies.

The present collection contains some very well-preserved specimens, and Mr. Goodwin is to be complimented on the care with which he has disinterred them. The good state of preservation of several of the skeletons argues also, however, for a fairly recent date of burial.

But it is not only prehistoric infant material that is scarce: I do not know of any extensive collection of young skulls of any race. Consequently there is very little to be found in anthropological literature concerning the morphology of the infant skull, so that I have not been able to compare these infants with the children of other races at corresponding ages. I have thought it worth while, however, to try to estimate their own rate of growth and to study their morphology, contrasting this with that adult norm towards which they would have tended, had fate not otherwise decreed.

The Infant Limb Bones.

The epiphyseal extremities of the infant bones, having been cartilaginous or only in a rudimentary state of ossification, have naturally disappeared, so that all the measurements have been made on the diaphyses

or shafts, and in each case it is the maximum length which has been taken. When the bones of both sides are available, the average between the two sides is given. Table VI contains the measurements of the series of skeletons studied, and it shows the gradual increase in length of each bone, as we ascend the age scale.

TABLE VI.

Measurements of Shafts of Infant Limb Bones.

Skull.	..	..	..	6*b*.	..	9.	9A.	I.	..	..	6*d*.	M.	N.	O.	..
Age.	6½–7	6½–7	6½–7	6–6½	4–4½	3½–4	3½–4	1½–2	1–1½	1–1½	½–1	B–½	B–½	B–½	B–½
Identity mark.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	N.	O.	P.
Clavicle	97	84	97	93	72	66	74	64	55	60	49	43	45	42	..
Scapula length	..	78	88	86	62	51	60	53	48	..	40	33	35	31	32
Scapula breadth	..	59	58	57	47	44	43	40	38	..	32	28	28	27	27
Humerus	186	150	192	..	146	122	125	105	100	95	74	64	64	62	68
Ulna	152	..	174	..	113	103	104	92	86	..	63	59	60	60	62
Radius	138	119	157	..	103	94	94	83	78	76	56	50	53	53	..
Innominate length	..	121	..	126	99	86	87	80	68	..	60	..	..	..	..
Innominate breadth	..	74	..	82	68	60	60	53	44	..	40	..	35	32	29
Femur	260	208	205	..	..	166	166	139	135	112	98	79	75	78	77
Tibia	214	..	..	..	..	139	137	117	106	102	82	66	66	67	69
Fibula	208	..	..	..	..	133	131	110	..	..	75	62	62	61	65
Radio-humeral index	74	79	82	..	71	77	75	79	78	80	76	78	83	85	..
Tibio-femoral index	82	..	..	..	..	84	83	84	79	91	84	84	88	86	90
Humero-femoral index	72	72	94	..	..	73	75	90	74	85	76	81	80	88	88
Intermembral index	68	..	..	..	..	71	72	73	74	80	72	79	83	79	..

The most interesting feature is in connection with the proportions of the limb segments, as shown by the values for the various indices.

The radio-humeral index ranges from 85 in the youngest individual to 71 in an older specimen, the former being considerably higher and the latter considerably lower than the adult index of 79 for both sexes. There does appear, however, to be a slight tendency in the younger specimens to exhibit the simian feature of a relatively long radius. Again in connection with the tibio-femoral index there appears to be a definite tendency for the tibiae to be relatively long, the indices of the younger members being high compared with the adult index of 83. The humero-femoral index ranges from 94 to 72, none of them quite reaching the adult index of 70. There is, therefore, a more definite simian tendency in this respect, and, although not limited to, it is more prevalent in, the younger infants. The inter-

membral index ranges from 83 to 71, again failing to reach the average adult index of 69, so that these youngsters, especially the younger individuals, must have had, to a degree, the relatively long simian arm. How far these features differ, if at all, from those of infants of other races will only be ascertainable when an opportunity arises for studying corresponding data from other racial groups. Considering that the calculations of the indices from the shafts are not strictly comparable with the adult indices which are calculated from the whole bones, there is a remarkable approximation to the adult proportions in the older individuals, thus suggesting that the modified measurements adopted give a very good indication of the limb lengths, and that the adult proportions are reached at the age of six or seven.

The Infant Skulls.

Dioptographic drawings of a series of infant skulls are presented in figs. 1 to 6, whilst Table VII contains detailed measurements of all the available material.

The relatively quick transition that takes place from the infant to the adult type of skull may be gathered from the fact that in the period between

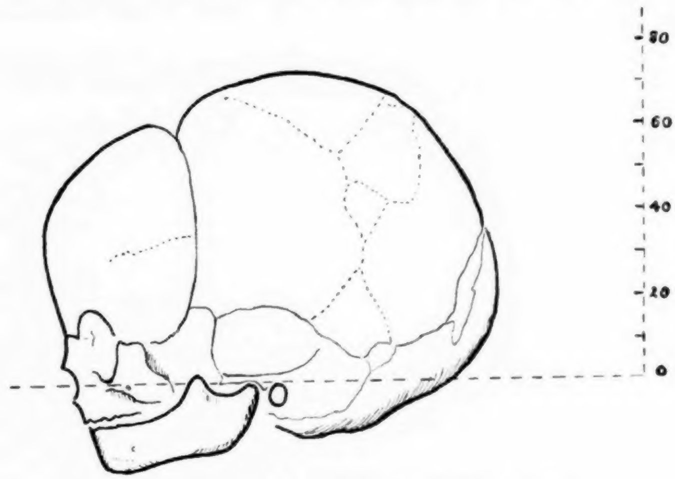

Fig. 1.—Skull N, that of an infant about the age of birth.

the age of six months and the fifth or sixth year the linear dimensions increase from over 50 per cent. to over 90 per cent. of the average adult figures. The outstanding feature in the linear dimensions of the cranium is the accentuation of the breadth in relationship to both length and height,

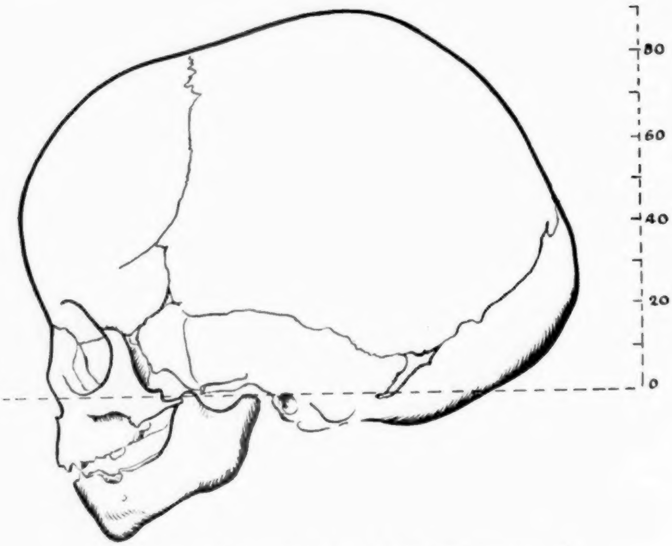

FIG. 2.—Skull L (6*d*), that of an infant about one year old.

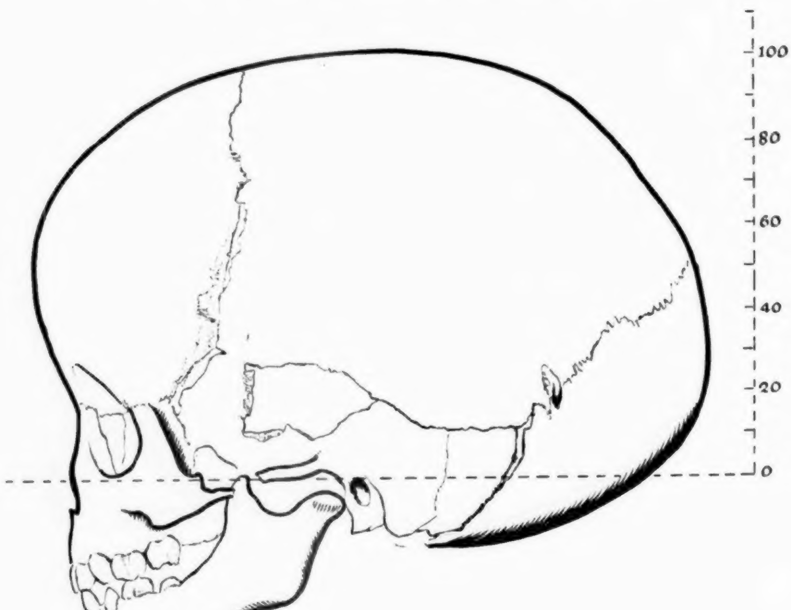

FIG. 3.—Skull I, that of an infant about two years old.

especially in the younger specimens. This is well brought out by the cranial (cephalic) indices, six of the ten crania being brachycephalic, three mesaticephalic, and only one dolichocephalic, in great contrast to the dolichocephaly of the adults. That the expansion in breadth is relatively ahead

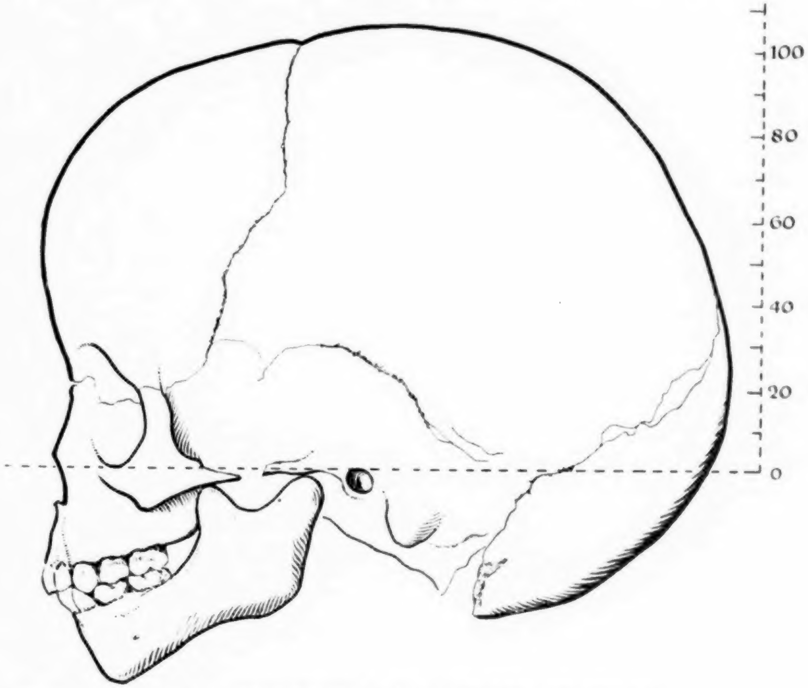

FIG. 4.—Skull G (9), that of an infant about four years old.

of expansion in height in these early years is shown by the general lowness of the height-breadth indices. On the other hand the average altitudinal index is 71, the same as in the adult, showing that growth in length and height maintains a fairly constant ratio irrespective of age. Although a slight tendency to show a gradual reduction in breadth can be detected in this series, it is obvious that the final reduction to the adult proportions must take place at a somewhat later period than the present series takes us.

It is difficult to explain this manifestation of brachycephaly in these infants. It may merely indicate that they are mostly females, although the relative shortness of their heads is greater than it is even in the adult females. We must remember also that it may be merely a transient

adaption of the foetal head in this dolichocephalic race to facilitate its passage through the pelvis in parturition.

On the other hand, if it should turn out that a temporary brachycephaly is not a constant feature of our dolichocephalic African races, it may be

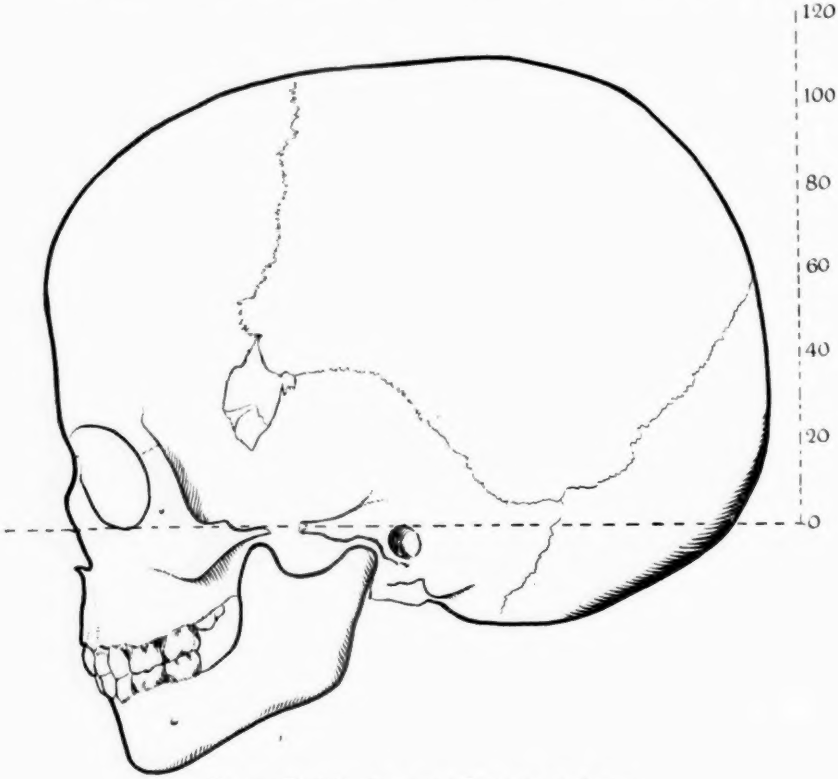

Fig. 5.—Skull 12, that of an infant in its sixth year.

necessary to explain it on morphological grounds. It is tempting to suggest that this brachycephaly in the ontogeny of Hottentot types may be indicative of some distant phylogenetic relationship with the Northern and Oriental short-headed types. In another connection (1937), I have recently advocated the thesis that the mesaticephalic Bushman has a number of morphological affinities with the Mongolian races. If the Bushman proves ultimately to have a Hottentot type of ancestry, then the Bushman must be regarded as his pedomorphic successor. That is to say, the Bushman

manifests in his adult skull a degree of brachycephaly which the Hottentot only shows in infancy, but which nevertheless may have a genetic basis linking him with brachycephalic Mongolian types.

An attempt has been made to assess the regional growth of the cranium

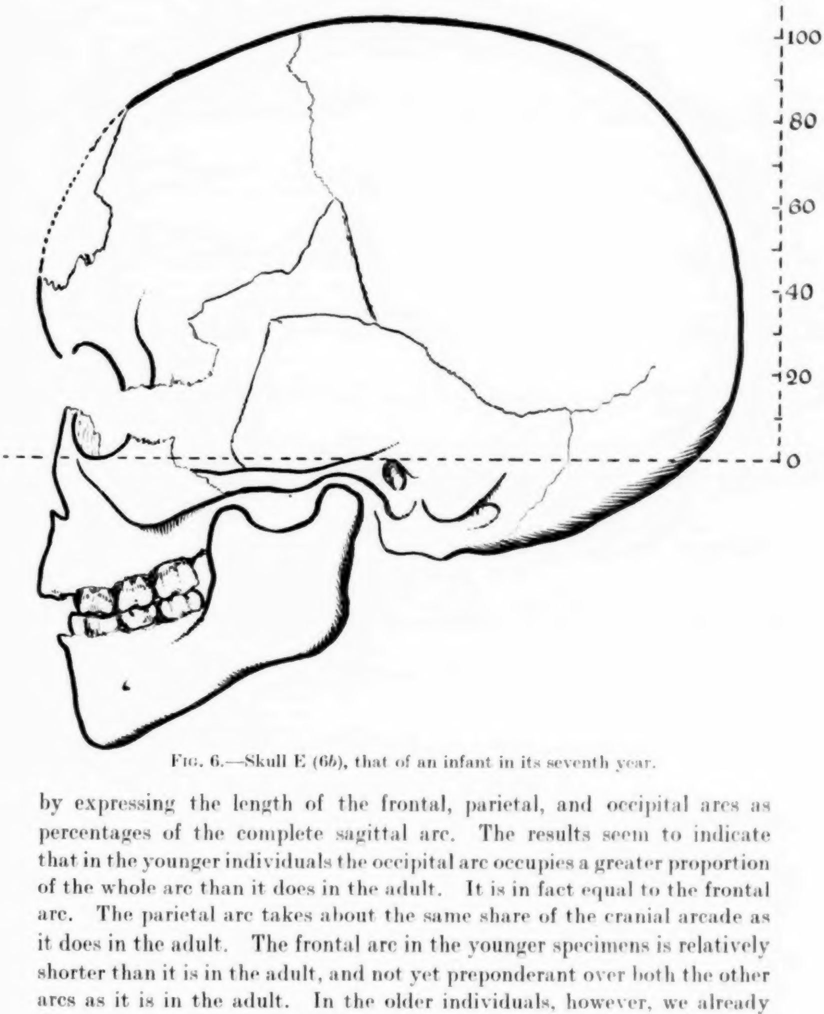

FIG. 6.—Skull E (6*b*), that of an infant in its seventh year.

by expressing the length of the frontal, parietal, and occipital arcs as percentages of the complete sagittal arc. The results seem to indicate that in the younger individuals the occipital arc occupies a greater proportion of the whole arc than it does in the adult. It is in fact equal to the frontal arc. The parietal arc takes about the same share of the cranial arcade as it does in the adult. The frontal arc in the younger specimens is relatively shorter than it is in the adult, and not yet preponderant over both the other arcs as it is in the adult. In the older individuals, however, we already find the adult proportions established.

TABLE VII.

Measurements of Infant Skulls.

Number.	12.	6*b*.	9.	9A.	6*a*.	I.	6*d*.	M.	N.	O.
Limbs.	?	E.	G.	H.	?	I.	L.	M.	N.	O.
Age.	5–5½	6–6½	3½–4	3½–4	1½–2	1½–2	½–1	B–½	B–½	B–½
Maximum length .	170	166	160	164	161	153	126	100	103	105
,, breadth .	131	133	129	132	118	120	111	88	86	87
Basion-bregma height	124	121	110	115	116	113	86	..	73	..
Aur. height . .	108	104	104	105	106	99	86	75	72	69
Min. frontal diam. .	84	101	82	85	76	82	67	..	63	..
Max. bizyg. diam. .	91	102	86	87	..	85	70	..	..	..
Max. bimastoid diam.	90	104	87	97	..	85	..	..	..	..
Nasion-prosthion .	44	48	42	43	..	40	33	..	..	..
Basion-prosthion .	82	88	73	72	..	..	58	..	..	..
Basion-nasion . .	89	84	72	76	..	..	60	..	..	..
Nasal breadth . .	20	23	18	19	..	19	16	..	..	..
,, height . .	30	35	32	32	..	30	23	..	..	..
Interorbital breadth.	18	..	19	19	..	18	16	..	..	..
Orbital height . .	31	..	31	30	..	28	24	..	21	..
,, breadth .	35	..	33	33	..	30	25	..	25	..
Nasion-menton height	80	82	70	69	..	69	52	..	33	..
Sagittal arcs:										
Frontal . .	135	120	115	120	112	110	90	75	73	70
Parietal . .	125	125	120	125	111	115	95	80	82	85
Occipital . .	105	100	115	110	107	100	88	75	73	70
Total .	365	345	350	355	330	325	273	230	228	225
Transverse arc. . .	310	285	295	290	..	300	..	220	200	..
Horizontal arc. .	485	480	460	475	440	440	373	..	300	..
Cranial capacity .	1216	1180	1129	1172	1085	1019	811	632	620	618
Cranial index . .	77	80	81	81	73	78	88	88	84	83
Mean height index .	82	81	76	78	83	83	73	..	77	..
Altitudinal index .	73	73	69	70	72	74	68	..	71	..
Height-breadth index	95	91	85	87	98	94	77	..	85	..
Upper facial index .	48	47	49	49	..	47	47	..	..	..
Nasal index . .	67	73	56	59	..	63	70	..	..	..
Orbital index . .	89	78	94	91	..	93	96	..	..	..
Cranial module .	142	140	133	137	132	129	108	..	87	..

TABLE VII.—*continued.*

Number.	12.	6*b*.	9.	9A.	6*a*.	I.	6*d*.	M.	N.	O.
Limbs.	?	E.	G.	H.	?	I.	L.	M.	N.	O.
Age.	5–5½	6–6½	3½–4	3½–4	1½–2	1½–2	½–1	B–½	B–½	B–½
Total facial index .	88	80	81	81	..	81	74	..	..	..
Gnathic index . .	92	105	101	95	..	..	97	..	..	..
Subgnathic index .	49	57	58	57	..	..	55	..	..	..
Frontal index . .	37	35	33	34	34	34	33	33	32	31
Parietal index . .	34	36	34	35	34	35	35	34	36	38
Occipital index .	29	29	33	31	32	31	32	33	32	31
Mandibular length .	71	83	68	70	59	64	49	43	41	42
,, breadth .	84	92	79	85	74	79	65	62	56	61
,, index .	85	90	86	82	80	81	75	69	73	69
Ramus breadth .	27	32	25	25	24	22	19	16	16	15
,, height . .	28	29	25	25	20	24	20	16	14	16
,, index . .	96	110	100	100	120	92	97	100	119	94

GROWTH OF THE FACE.

With regard to the face, the width as measured by the zygomatic diameter is definitely more advanced than the length of the face, as measured by the nasion-prosthion dimension. This is in conformity with the increased breadth of the cranium at this stage, to which reference has already been made. The short broad face of these infants is clearly brought out by the upper facial indices, all of which are chamaeprosopic, in contrast to the leptoprosopic adults. The face is also short relative to the basal length of the skull, as is shown by the low subgnathic index. Although orthognathous, these infants are in general less so than the adults.

The orbits have the usual high rounded simian apertures characteristic of infants of other races. The nasal apertures are platyrrhine to a marked degree, the average nasal index of 65 being still higher than the high index of 60 found in the adults of this tribe.

In Table VIII an attempt has been made to determine, after Krogman (1934), the direction in which growth of the face takes place, and to study the size of certain of the facial components. This table contains four radial dimensions taken from the porion in order to measure forward growth, and three radial diameters taken from the nasion with which

to gauge downward growth. The last measurement from acanthion to prosthion indicates the state of development of the upper alveolus.

TABLE VIII.

Age.	B–½	B–½	½–1	1½–2	3½–4	3½–4	5–5½	6–6½	Adult range.	Adult average, ♂ and ♀.
Identity mark.	N.	M.	L.	I.	9A.	9.	12.	6*b*.		
Porion-nasion .	51·0	44·0	57·0	68·0	71·0	70·5	79·0	..	86·0– 96·0	90·0
Porion-acanthion .	48·0	44·0	54·0	68·5	69·5	72·0	78·0	82·0	83·0–104·0	91·0
Porion-prosthion .	46·0	48·0	56·0	70·0	73·0	76·5	81·0	89·0	88·0–107·0	97·0
Porion-orbitale .	40·0	36·5	47·0	56·5	..	57·0	66·0	69·5	75·0– 86·0	79·0
Nasion-prosthion .	20·0	26·0	31·5	38·0	40·0	43·0	44·0	..	48·5– 67·0	57·0
Nasion-acanthion .	16·0	18·0	21·5	26·0	28·0	29·0	26·0	..	33·0– 47·0	39·6
Nasion-orbitale .	16·0	11·0	18·0	20·5	..	23·0	30·0	..	19·0– 30·0	22·0
Acanthion-prosthion	5·0	7·5	10·0	12·0	11·5	14·0	18·0	20·5	14·0– 21·0	17·0

It is interesting to see that growth is progressive in all directions, and to note that although the face at the age of five or six is not quite of minimum adult size, yet there is every indication that by the age of seven this lower limit of the adult range is reached. This leaves a considerable amount of leeway still to be made up in the later years of childhood before the mean dimensions of the adult face are reached. Judging by the gradients, however, and by the correlated measurements of the mandible, I am of opinion that completely adult proportions are attained at an early age.

GROWTH OF THE MANDIBLE.

In Table IX certain linear measurements of the mandibles of these infants are set out. With the exception of the breadth dimension, which is taken from the actual bone, all these measurements have been taken from projection drawings. The base-line used is that of the lower border of the jaw, as recommended by Morant (1936), and the majority of the measurements given are vertical heights above this. The length is the distance between vertical tangents to the symphysis menti and to the condyloid process respectively. The minimum width of the ramus is given, irrespective of the angle at which it is taken.

These measurements show a progressive increase in the various directions measured in keeping with the gradual advance in age. In the last two columns of the table I have given the range of variation in the Oakhurst adults, the lower limit being usually from a female and the upper from a male mandible. If one compares the measurements from the infant

mandibles with these extremes of the adult dimensions, it can be seen that none of the infant mandibles have yet reached the lowest adult dimensions of length or breadth. Nevertheless most of the other measurements, such as the height of the infradentale, of the body, and of the processes have, by the sixth or seventh year, all exceeded or are only just short of the adult minimum. By that time also the ramus width has become of adult size.

TABLE IX.

Age.	B–½	B–½	B–½	½–1	1½–2	1½–2	3½–4	3½–4	5–5½	6–6½	Adult range.	Adult average, ♂ and ♀.
Identity mark.	O.	N.	M.	L.	I.	6*a*.	9A.	9.	12.	6*b*.		
Mandibular length	43·0	40·5	42·0	47·5	66·0	57·5	65·0	66·0	75·0	82·5	91·0–112·0	103·0
,, breadth	58·0	55·0	61·5	68·0	79·0	74·0	85·5	79·0	85·0	90·0	107·0–118·0	112·0
Height of infradental point	10·0	12·5	13·0	17·0	20·0	16·0	18·5	19·5	22·0	29·5	30·0– 36·5	32·0
Height of body	9·5	11·0	11·0	13·0	16·5	15·5	15·5	17·0	17·5	21·0	20·5– 27·0	25·0
,, coronoid	19·0	18·5	18·0	23·0	33·0	27·5	34·0	33·0	39·0	40·0	45·0– 55·5	48·0
,, notch	14·0	12·5	14·0	15·0	19·0	17·5	20·5	23·5	26·0	29·0	25·0– 40·0	35·0
,, condyle	15·0	13·0	14·5	16·0	20·0	18·0	24·0	26·0	27·5	32·5	29·0– 48·0	41·0
Width of ramus	14·5	16·0	16·0	18·0	21·0	27·0	25·0	25·0	28·0	33·5	29·5– 40·0	35·0
Mandibular angle	127°	129°	130°	134°	142°	130°	133°	130°	134°	123°	113°–144°	124°
Mandibular index	74·1	73·6	68·3	69·9	83·5	77·7	76·0	83·5	88·2	91·7	84·0– 98·0	93·0
Ramus index	103·6	128·0	114·3	120·0	110·5	154·3	121·9	106·4	107·7	115·5	89·4–120·0	102·0
Ramus height-length index	32·6	30·9	22·8	31·6	28·8	30·4	31·5	35·6	34·7	35·2	25·0– 37·5	34·0

When the mandibular length is expressed as a percentage of the breadth, as in the mandibular index, there is definite evidence that growth in length of the mandible is more intensive than that of breadth. This harmonises with the lengthening which the brachycephalic cranium of these infants has to undergo in order to acquire the dolichocephalic proportions of the adults.

The ratio of the width of the ramus to the height, as shown by the ramus index, is consistently high, and there is no sign of any change in the shape of the ramus at any of the ages studied. Similarly the relationship between the height of the ramus and the length of the mandible, as reflected in the ramus-length index, is very much the same as in the adults, whose rami are characteristically short. The mandibular angle also appears to be a consistently open one without any age gradation.

On the whole, therefore, it would seem that at quite an early age these infant mandibles attain to a very close correspondence with the adult mandibles both as regards size and shape. In the absence of comparative

data I am unable to say whether these infants are or are not unduly precocious in this respect. It is quite possible, however, that they may be, but the quick approximation to the adult is probably more apparent than real. It may not be so much a case of acceleration of differentiation in these infants towards the adult form, as a retardation of the adult differentiation with retention of the infantile shape, which latter phenomenon is now regarded as characteristic of Bushman types.

Cranial Capacity and Brain Growth.

Of outstanding importance is the information which these infant skulls afford us regarding the rate of growth of the cranium and therefore of the brain in this race. Owing to the fragility of these young skulls, it is not possible to measure their capacity by any of the direct methods, so that recourse had to be taken to indirect estimation from the linear measurements by using the following regression formula devised by Pearson:—

$$\text{Capacity} = \cdot000337(\text{L.} \times \text{B.} \times \text{Aur.H.}) + 406{\cdot}01.$$

If we take 1300 c.c., which is the average cubic capacity of the adult population of this cave, as the standard towards which these children would have grown in adult life, then their brains had reached the following percentages of their adult size.

The three youngest skulls, which I estimate to have been about six months old, had reached 48 per cent., 48 per cent., and 49 per cent. respectively of their adult growth. A one-year-old individual had reached 62 per cent., and two two-year-olds had attained 78 per cent. and 83 per cent. respectively. Two about four years old had increased to 87 per cent. and 90 per cent. One about five years old had attained 94 per cent. of the adult figure, and one six years old had a capacity which is 91 per cent. of the adult standard.

It is instructive to compare these percentages with those which Wingate Todd (1931) gives for the European infant. At birth the European brain is 20 per cent. of its adult size, at six months 50 per cent., at two years 75 per cent., and at six years 85 per cent. of what it will ultimately grow to. The figures from the Oakhurst children seem therefore to suggest that the growth of the Hottentot type of brain is, if anything, even more precocious than that of the European.

Summary.

In this paper I have submitted measurements of the skeletons of a series of infants from the Oakhurst cave, which Mr. A. J. H. Goodwin kindly entrusted to me for examination. The dimensions of the shafts of

the long bones are set out in Table VI, and the various cranial measurements are detailed in Table VII.

As these skeletons are from children of different ages, presenting in fact a very good series from birth to the age of about six, I have used the rather unique opportunity afforded by them to study the rate of growth in the skull, face, mandible, and brain of these cave-dwelling infants.

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ARCHAEOLOGY OF THE OAKHURST SHELTER, GEORGE.

PART V. THE POTTERY.

By J. F. SCHOFIELD, A.R.I.B.A.

(With two Text-figures.)

(Read April 21, 1937.)

The pottery from this site is, on the whole, very fragmentary, but it has been found possible to reconstruct two vessels sufficiently to obtain an accurate idea of their original form.

1. The more complete of these is an ovoid-necked pot, 80 mm. over the rim, 206 mm. at its greatest diameter, and 260 mm. in height.

The clay is gritty and grey, and varies from 4 to 6 mm. in thickness. The surface generally has,.at present, a blackish matt finish, but as there are traces of red at the shoulder it is probable that black was not the original colour.

The rim is rounded with a slight roll on the outside, and the neck sweeps downwards and outwards to a clearly defined junction with the body of the pot. It is decorated with lightly scratched lines, which form a rough hatching.

The body is ovoid, and has a small boss, raised from the inside, just below the shoulder.

2. A rough pot, 203 mm. over the rim, and with a similar, or slightly greater, height.

The clay is black, exceedingly coarse and gritty, 5 to 8 mm. in thickness, and finished with a rough grey surface.

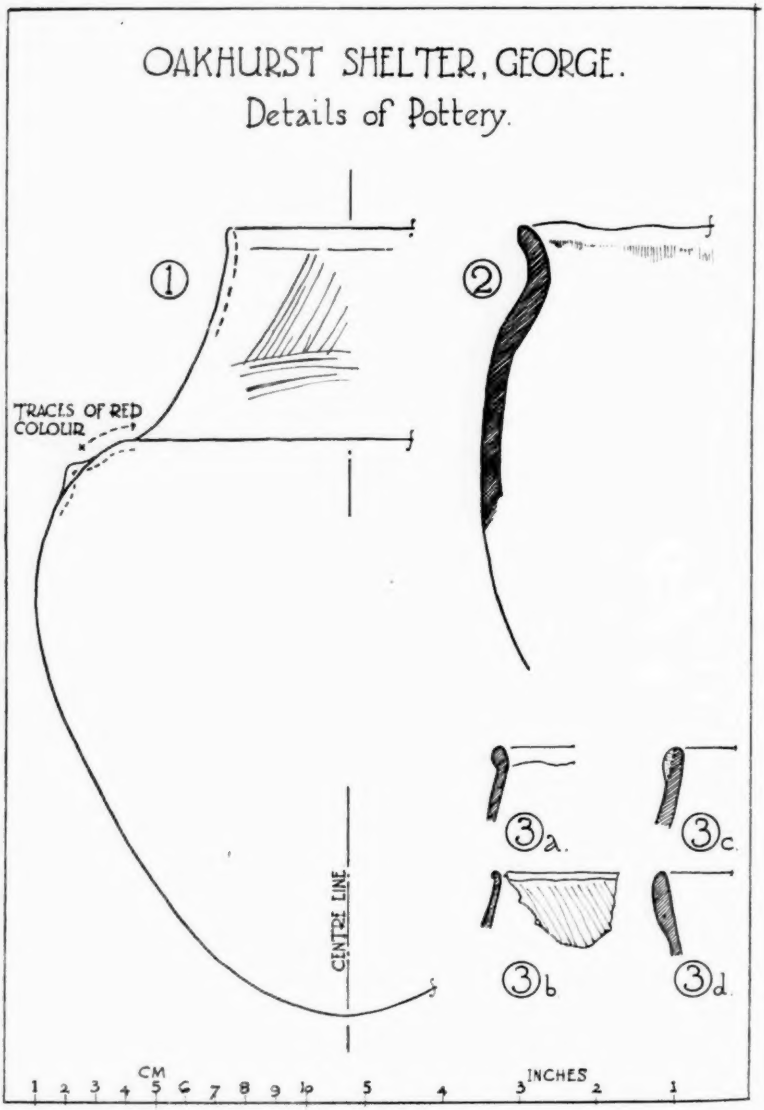
The rim rounded, slightly flared, and very uneven.

The body is roughly shaped, but is in too fragmentary a condition to decide its original shape with any certainty.

3. Fragments.

(*a*) A rim shard of a pot, probably 165 mm. in diameter.

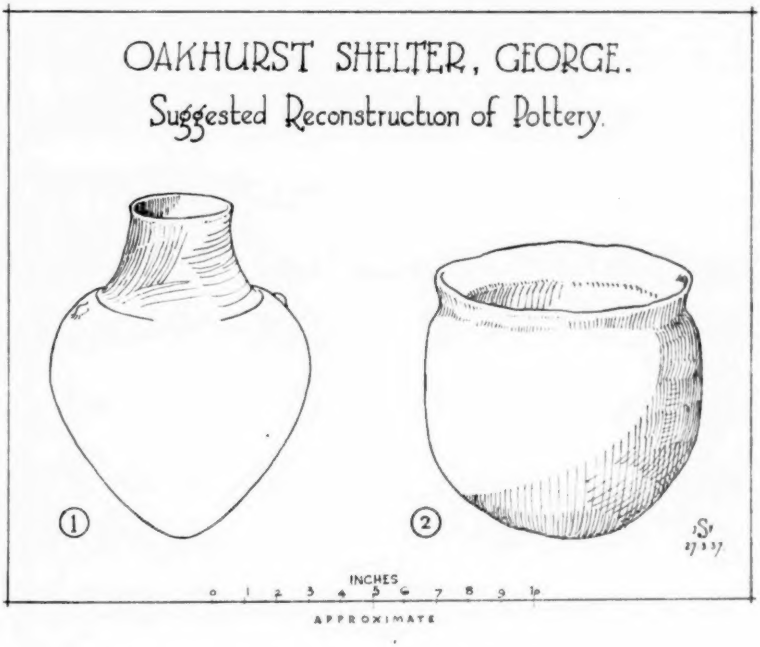
The clay is very fine, the pot wall being only 4 mm. in thickness. The surface has a rust-coloured matt finish.


OAKHURST SHELTER, GEORGE.
Details of Pottery.
①
②
TRACES OF RED COLOUR
CENTRE LINE
③a.
③b
③c.
③d.
CM
1 2 3 4 5 6 7 8 9 10
INCHES
5 4 3 2 1

The rim is rolled to a diameter of 3 mm., the lower edge of the roll being uneven.

(*b*) A rim fragment as last, but the clay is finer and only 3 to 4 mm. in thickness.

The neck is finished with a rust-coloured burnish, and is decorated with lightly scratched hatching.



The rim is rolled to a diameter of from 2 to 3 mm.

(*c*) Rim fragment in fine grey clay, 5 mm. in thickness. The surface has a sepia matt finish.

The rim is rolled, the roll being formed with a lighter coloured clay which was planted on after the neck had been made.

(*d*) A rim fragment in a gritty grey clay, finished with a brown matt surface.

The rim is rounded and thickened on the outside.

(*e*) Several in a light grey clay, finished with a deep red matt surface on one side, and having one edge splayed. It is probable that these formed part of the junction between the body and the neck of a vessel.

(*f*) Several fragments of pot bodies in a light grey clay, finished with a fine black burnished surface.

(*g*) Several horizontally pierced and internally reinforced lugs. In some of these the bridge between the apertures is pointed, and in others it is rounded. It is evident that these last originally formed parts of the shoulders of pots similar to that described under (1).

Technique.

From an examination of the shards it is impossible to say with any degree of certainty whether the gritty content of the shard is natural, or whether the grit has been added. Certainly the presence of grit does not improve the plasticity of the clay, and therefore it seems probable that the grit is natural, and that the clay was found along the edges of standing water, where traces of tannic acid, derived from decaying vegetation, would render it unusually plastic.

It is also impossible, owing to the way in which the surfaces of the pottery have been finished off, to be definite regarding the way in which the pots were constructed. It is likely that, as Laidler states, the ovoid pots were commenced at the shoulder, and built up, in an inverted position, by the addition of successive rings of clay, and that the neck was added last, for certainly the fragments described under 3 (*e*) above give colour to these views.

As has been noted above, the surface of the finer pots had a burnished or a matt finish, and were coloured rust red, deep red, brown, sepia, and black. Several of the shards have been decorated, while wet, with a lightly scratched hatching.

The mark which sets this pottery apart from all other South African wares is the use of the horizontally pierced and internally reinforced lug. It would appear that this type of lug was made by compressing a lump of clay into a lenticular mass between the palms of the hands, and then forcing it into the undried pot well with one hand, while the outside of the pot was supported by the cupped palm of the other hand. The projecting boss thus formed was then pierced horizontally from both sides, the orifices rounded off, and the bridge between them moulded to a point, or left smooth, apparently in accordance with the whim of the maker or the shape of the pot.

Historical References.

The notices regarding pottery are very scanty in the writings of the early Dutch colonists. William Ten Rhyne (1686) states that "the richer amongst them (the Hottentots) make most beautiful clay pots for use in cooking" (E.C.H., p. 121).

Gaevenbrock, writing in 1695, gives a more detailed account, and describes how the clay was dug, tempered, moistened, worked into cylinders an ell in length, and how the pot was built up with these from the bottom upwards. The green pot was then smoothed by hand or with a sea-shell and coloured red. It was set aside to dry in the shade, and finally, after the fixing of the handles, it was burnt with cow dung fuel (E.C.H., p. 253).

Kolbe (1704–1713) noted that clay from ant hills was used, and that after ridding it of sand and gravel it was mixed with ants' eggs. The pot was moulded on a flat stone, and after drying it was burnt to a jet black.

Sparrman (1772–1776) remarks that it is "an uncommon thing for a Hottentot to have earthen vessels of his own manufacture for the purpose of boiling or stewing his victuals" (S.V., vol. ii, p. 338).

Le Vaillant (1781) states that the Hottentots used their exceedingly brittle earthenware for the purpose of melting grease (Le V., vol. ii, p. 72).

Comparative Material.

Pottery essentially similar to our material has been recorded from numerous coastal sites between Walvis Bay and Umhloti in Natal, while inland sites are known as far north as the Orange River (Péringuey, Annals of S.A. Museum; Laidler, S.A. Journ. Sci., vol. xxvi; Schofield, *ibid.*, vol. xxxiii).

Up to the present this pottery has not been recorded from the Transvaal or the Rhodesias, although ware having a strong superficial resemblance to 3 (*d*) was taken on the Salisbury Commonage Sites.

Writing in 1838 Alexander notes that "clay cooking pots of a conical shape were in every hut" of the Hill Damara (A.E., vol. ii, p. 135). Unfortunately this pottery never seems to have been described. Conical pots are also recorded from amongst the Basoko of the lower reaches of the Aruwimi River, Congo Belge. These pots have no lugs, but are provided with raffia slings, by which they are suspended (A.M.C., vol. ii, pl. xvii).

Amongst the Kikuyu shouldered pots are made, of which the necks are decorated with incised lines and horizontally placed lugs. They generally resemble the Pella pot, but the ware is much coarser and the bodies are globular instead of ovoid (W.P.P., pp. 97–107).

In our opinion wares from Ovamboland resemble our pottery more closely than any other. The class of clay used, the burnished brindled surface, the lightly scratched decoration round the neck, and the small bosses at the neck-body junction, are all very similar in both wares. Against these resemblances we must note that the characteristic reinforced and horizontally pierced lugs are not made, but the vessels have raffia slings like the Basoko pottery; also that the bases are usually flattened.

Discussion.

We make no excuse for terming our pottery "Hottentot," because the historical evidence seems to us to be overwhelming for the identity of our pottery and that described by the early writers. Both potteries are coloured red and jet black, both have handles, both are brittle, both are described as beautiful, both were used for the storage of fat and for cooking, and, besides all this, the area over which our pottery has been recorded is within that occupied, at one time or another, by the Hottentot tribes.

So we must conclude that pottery was being made by the Hottentots of the Cape at the time of their first contact with Europeans. As a result of that contact and the introduction of foreign wares, the art of pottery-making was gradually lost, and probably became extinct in the Colony towards the end of the eighteenth century. Further, since the Houteniqua tribe of Hottentots occupied the George district our pottery might, not unreasonably, be ascribed to them.

We do not believe that the Oakhurst pottery represents two or more different traditions, for amongst all peoples vessels of honour and vessels of dishonour exist, and the divergences we have noted are not greater than those found in our own domestic wares. A similar pot to the one with the flared rim (2) has been recorded from Cape Town, and is reminiscent of the pots used as sound boxes for musical bows.

The highly developed technique displayed in this pottery, more particularly in the construction of the pierced lugs, seems to demand a long period of development, and makes it unlikely that it is of recent origin; while the superficial deposits in which it is found warrant the assumption that its introduction into South Africa was comparatively recent. The great length of inhospitable coast over which the pottery-bearing sites are found makes it probable that our pottery was diffused along the river valleys from some common centre in the Orange Free State.

Since the pots were used as much for storage as for cooking, the pierced lugs were doubtless used for suspending the pots on the pack-ox during the frequent déménagements necessitated by the nomadic habits of the Hottentots, and we suggest that the oval section occasionally seen in the larger pots is another adaptation in the same direction. Alexander records vividly enough the loading of a pack-ox with the entire worldly possessions of a Namaqua household, including the hut and the children, while "the earthen cooking pots and milk bambus (wooden vessels) hang from forked sticks on each side." (A.E., vol. i, p. 194). It is interesting to note that the wooden as well as the earthenware vessels were provided with lugs. The Kikuyu pottery, very reminiscent of the Pella pot, has the lugs merely

planted on, and the body rounded instead of ovoid in shape (W.P.P., pp. 97–102, pls. lxx–lxxvii).

It seems very probable to us that all the peculiar features of Hottentot pottery, such as the excessive thinness of the pot walls, the way in which some of the larger pots were flattened, with the major axis on the same plane as the lugs, and the construction of the lugs themselves, may be most easily understood by regarding them as adaptations of some such pottery as that of the Kikuyu to meet the requirements of pack-ox transport.

Summary of Conclusions.

We conclude that the Oakhurst pottery represents the homogeneous pottery industry of a Hottentot clan, and since the Houteniquas occupied the district in historical times, it may, not unreasonably, be ascribed to them.

It has no near affinities amongst modern South African pottery industries, with the possible exception of that of the Ambo.

It is suggested that the peculiar features of this pottery may have originated as modifications to adapt it to the requirements of pack-ox transport.

In the present state of our knowledge it is impossible to date pottery such as this with any degree of certainty. It is unlikely that it is of any great antiquity, and it is equally unlikely that it is later than the last quarter of the eighteenth century.

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ARCHAEOLOGY OF THE OAKHURST SHELTER, GEORGE.

Part VI. Stratified Deposits and Contents.

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(With six Text-figures.)

(Read July 21, 1937.)

The Cave Deposit in General.

In discussing the contents of the various layers it is important to bear in mind certain peculiarities of the site. The deposit lies in an open shelter in the heart of the forest. The major part of the deposit consists of decayed vegetable matter with a high percentage of wood-ash. Leaf-mould and a care-free use of wood fires account for much of the depth. In addition there are vast quantities of shell present throughout the deposit, and though in the lower layers these have been compacted, in the upper part they are whole, and they too account for a considerable proportion of the bulk. The apparent scarcity of implements in the upper layers is thus only relative to this bulk of wood-ash, leaf-mould, and shell. The upper layers do not, therefore, represent a great period of time.

An additional factor has to be taken into account. It is to be observed that owing to the open nature of the shelter, it could not have provided much protection until the floor deposit had been built up considerably. This accounts for the absence of any signs of real inhabitants in the shelter before the Smithfield B deposit was formed. The shelter at that time was a high one, affording no real protection from the rain. The lower layers have all been considerably affected by rain beating into the shelter and by water running the whole length of the site. The upper layers show no such action, and have been amply shielded from rain. As a result, while the lower levels contain hard, compactly cemented masses of insoluble material, the overlying deposit is loose and dusty, still containing the maximum of soluble material.

The prevailing stone used by all the implement makers who lived in the shelter was white quartz. A hundred yards above the shelter (to the north)

a vein of quartz has been quarried, and it is obvious that local quartz veins in the Table Mountain sandstone supplied all the major needs of these people. In addition other stones, agates and chalcedonies, were used. These were brought from neighbouring beaches, unless the sources of the beach pebbles were known to these people. The implements of quartz and quartz crystal are difficult to draw and even to recognise in many cases. Photographic reproduction gives worse results, and illustration has been restricted to drawing only.

The material as it is described here represents about one-half of the total material retrieved. Especial care had constantly to be taken to differentiate between stratified deposit, grave infilling, and grave furniture. The grave furniture has been described above (see Disposition of Skeletal Remains), the infilling of graves has been ignored, and we deal here only with the stratified material. There still remains a chance that implements have been displaced from lower levels and have been described here as part of the stratified material, but this possibility has been reduced to a minimum. There is nothing new or unusual in the grave infilling, and stratigraphically it is valueless. It has, however, been retained in case it is needed for further study.

The Wilton Material.

The uppermost 3 feet at the Oakhurst Shelter consists generally of Wilton material. At the base of this deposit (30 inches at the southern end, and 36 inches elsewhere) the Wilton is apparently normal. Stone crescents in white quartz and in chalcedony are common, and small bead-borers and flakes occur. This level is the point of contact between the underlying Smithfield C deposit and the Wilton.

Following this short Normal Wilton phase (represented by only an inch or so of deposit) comes a long period during which crescents cut from *Mytilus edulis* shell replace the usual stone crescents. So much is this so that the number of stone crescents found in the uppermost 35 inches is about equal to that of the crescents found in the single inch of Normal Wilton deposit. Apart from this change from stone to shell there appears to be little change in the Wilton, save for the very important addition of pottery (described above by Mr. Schofield) and a general increase in the number of bone tools to be observed in the top 9 inches.

Though the deposit was excavated for a time in four 2-inch layers, these were later changed to 9-inch layers, as no difference in the general material found in the uppermost 35 inches could be observed. In the following description the uppermost 9 inches has been described in detail, while the remainder has been dealt with only so far as slight variation is evident.

Uppermost Layer (0–9 *inches*).

Fauna.—The following faunal remains have been identified by Dr. K. H. Barnard of the South African Museum, Cape Town. The collection of mollusca submitted to him may be taken as completely representative of the uppermost 9 inches of deposit. The mammal and fish-bone collection is not representative.

Mollusca.—*Donax serra*, *Mytilus edulis*, *Ostrea* sp., *Glycineris* (*Pectunculus*), *Solen* sp., *Turbo sarmaticus*, *Oxystele merula*, *Conus* sp., *Cyprea edendula*, *Bullia digitata*, *Burnuperia* (*Cominella*), *Nassaria kraussi*, *Phasianella kochi*, *Haliotis sanguinea*, *Patella cochlea*, *P. plicata*, *P. longicosta*, *P. pruinosa*, *Siphonaria* sp., *Tropidophora ligates* (a land shell), and *Ena carinifera*, probably adventitious.

Mammals.—Two incomplete sets of tusks and teeth of wild pig. Various bones of same. Portion of small buck skull, several jaws of small buck. Small carnivore. Porcupine teeth, *Otomys* teeth.

Fishes.—Supra-occipital bone of large fish, probably Biskop. Dorsal spine of Biskop (*Pagrus*). Jaw of elft (*Pomatomus*). Otolith of Kabeljauw, Biskop, or Steenbras. Dental plate of Eagle Ray (*Myliobatis*). Various other fish-bones.

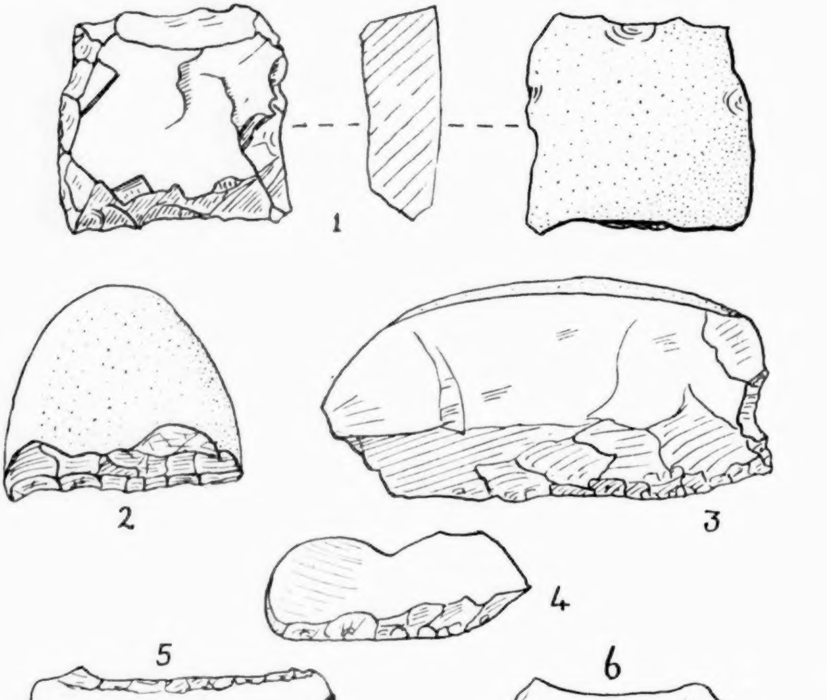
The fauna as a whole calls for no great comment. The mollusca are typical of the present ocean in this region, and no change in fauna is to be observed throughout the whole of the cave deposit. The mammal and fish remains are not so easily identifiable, and the only additional types noted were remains of Zebra and Buffalo. Both are still to be found where they have not been exterminated by civilisation.

Pottery.—All the pottery described by Mr. Schofield comes from the top 9 inches of the deposit.

Stone Implements.—The stone used is generally white quartz. In addition quartz crystal, chalcedonies, cherts, and quartzitic Table Mountain sandstone are employed.

Larger Types.—There is a general formlessness and crudity about the white quartz tools. Often they appear to have been chipped heavily to provide chance cutting edges and corners. A few large discoidal artefacts, identical with the forms persisting all through the South African Stone Age, have been made of quartzitic sandstone or quartz; probably these are chipped hammer-stones. This group shades into the formless pieces of white quartz on the one hand, and into relatively well-made (or used) trimming stones of Later Stone Age type on the other.

A broken fragment of a lower grindstone made on a river pebble and a number of upper grindstones of the same material are from this layer. The latter show little sign of use, and grinding is hardly evident. Where it



FIGS. 1-17.—(Actual size.) Stone implements from layer 0-9 inches.

is visible the usual typical central pitting is to be observed. Pebbles of similar type have been used as hammers, and marks of percussion are to be seen on suitable points and about the equators of the stones.

Most striking are a number of carefully formed scrapers, rectangular to circular in shape, made on flakes taken from pebbles of quartzitic sandstone, or from pebbes broken in two (figs. 1–4). The sea or river pebble has been split or broken and the resulting edge retrimmed, generally across the width of the stone, but in some instances along more than one suitable edge. We may regard these as conventional tools of the local midden culture. On showing a few specimens to Mr. Schofield he informed me that the tools here differ from the pebble material of the Natal coastal middens.

Smaller Types.—Small circular scrapers, often well made and up to $1\frac{1}{2}$ inch in diameter occur (figs. 7, 8, 9). The smallest measure $\frac{1}{3}$ inch in diameter, but the usual size is $\frac{3}{4}$ inch. In addition a few end-scrapers, and unconventional forms on chance flakes (figs. 5, 6), together with various burin-like forms (figs. 15, 16, 17) were recovered.

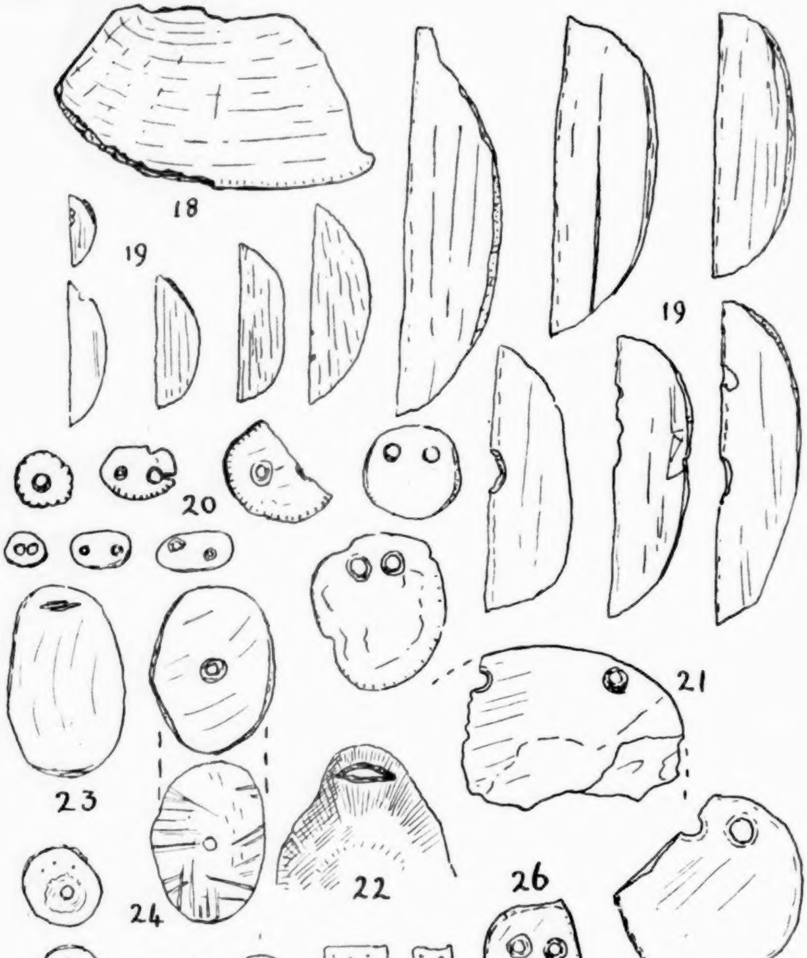
Through the whole 9 inches of deposit perhaps a dozen implements conform to the usual Wilton crescent, and of these (figs. 10–14) only a few are double-edged. On the Riversdale and Cape Peninsula coasts the single-edged type is the rarer.

Stone Ornament.—A flat fragment of river pebble bears part of a small hole, $\frac{1}{8}$ inch in diameter, bored for suspension. Nothing can be said of the original size of the pebble.

Ochre.—A few fragments of yellow and claret ochre were found, with a broken hæmatite nodule from which powdered ochre had been obtained. A few shells contain signs of ochre, while the presence of colouring matter on several gravestones suggests that the pigment was ground before use.

Shell—Shell Implements (figs. 18–19).—The most striking revelation in this particular shelter is the number of shell implements recovered. Fragments of *Donax serra* have been found carefully trimmed to an edge, but as only two or three specimens were recovered from each layer, their presence is hardly surprising (fig. 18). In addition to the Donax shell tools, a vast number of crescents of *Mytilus edulis* shells (Blue mussel) were recovered. Over two hundred and fifty specimens were obtained. Unfortunately the distribution of these cannot now be noted, as the tools were only recognised after a large part of the upper deposit had been removed. Once the significance of the material had been recognised, layer 18 inches to 27 inches yielded seventy specimens, and layer 27 inches to 35 inches well over a hundred. About thirty could be recovered from the upper layers (fig. 19). Many more specimens were seen, but they had been destroyed by fire.

The Mytilus crescents vary in length from $\frac{3}{8}$ inch to 2 inches. The chord



FIGS. 18–31.—(Actual size.) Shell ornaments and implements from layer 0–9 inches.

of the crescent in each case is formed by the outer edge of the shell, while the bulk of the shell has been neatly broken away to leave a perfect crescentiform tool. Experiment with fresh shells shows that it is possible to control their fracture. The left thumb is held over the portion wanted, while the remainder is snapped off. It is evident that in many cases two, three or more breaks have been made in the shell to get the final shape. In many instances the mid-point of the chord is notched, presumably from use. Even where no actual notch is visible, the implement often shows distinct signs of use at this point.

The presence of these shell crescents adequately explains the small number of stone crescents recovered in the top 35 inches of deposit. The complete absence of Mytilus crescents in the 36 inches test, taken in conjunction with the increased number of stone crescents at this one level, suggests very clearly that the shell crescent was a development after the Normal Wilton at this site, and that it had a sudden strong growth.

Shell Ornaments.—The simplest shell ornament is the nacre bead, bored and rubbed down to a circle in a manner identical with that employed in making ostrich eggshell beads. These nacre beads are rare, partly because they deteriorate quickly, and partly because they could never have provided much contrast with the eggshell bead.

A somewhat larger bead, about $\frac{5}{16}$ inch, and another specimen about 1 inch in diameter, have serrated edges (fig. 20). Two similarly serrated but smaller specimens have been bored with two holes each. In addition a few non-serrated specimens of the double bored bead were found. Several other discs, up to 2 inches in diameter (fig. 21) are too broken to merit further description.

Three oval nacre discs, spoon-shaped and cut from *Turbo sarmatacus* shells, were found. One (fig. 24) has been considerably cut on the outer face, probably to remove the skin of the shell, another shows signs of an attempt (fig. 23) to saw through one end. One *Patella cochlear* (fig. 22) has been sawn through at one end, either for suspension or for mounting as a spoon.

In addition to these a single cowry shell (*Cypraea* sp.) and numbers of naturally bored shells, *Nassaria kraussi, Glycineris conollyi* (*Pectunculus*), and *Phasianella* sp., have been brought up to the cave, presumably for use as ornaments.

Ostrich Eggshell.—Vast numbers of ostrich eggshell beads were retrieved. In a few cases whole lengths of bead necklaces seem to have been dropped, and beads were found lightly cemented together into sticks. The smaller beads which make up the bulk of the collection range from ·37 cm. to ·63 cm. in diameter, with an average of ·51 cm. In addition to a thousand or more of these beads, about a hundred slightly larger beads, ·73 cm. to 1·2 cm. (fig. 25) were found. These seem to fall outside the usual series.

One leaf-shaped fragment of eggshell (fig. 26), measuring 3 cm. by 1·7 cm., has had two holes bored into it asymmetrically. A circle 2·85 cm. diameter (fig. 27) has been doubly bored for suspension. One or two ostrich eggshell fragments bear signs of red ochre.

Ivory and Bone.—A hippopotamus tusk, cut off at the alveolar border, was recovered near the surface of the cave rear. A single ivory bead, flattened sphere, $\frac{3}{8}$ inch diameter (fig. 28).

A dozen bone borers (fig. 32) made from bird, fish, and animal bone. Six bone arrowpoints and linkshafts (fig. 34) of modern Bushman type. A single linkshaft (fig. 33) appears to be of rotting wood, and comes from near the surface.

Eight bone tubes (figs. 36, 37) were recovered. These had been cut and smoothly polished, probably in use. They vary in length from a $\frac{1}{2}$-inch bead-like fragment (fig. 29) to almost 3 inches (fig. 36). Most of the specimens show cuts parallel to and near one lip. The large specimen figured has fine cross-hatchings, confined to one end.

Two fragments of large flat bone beads (fig. 30) measure about $\frac{5}{8}$ inch in diameter. There has been some slight attempt to round off the outside. Apparently tortoise bone.

A fragment of a fire-making stick, similar to types used by modern Bushmen, was recovered near the surface.

Layer 9–18 *inches* (figs. 38–42).

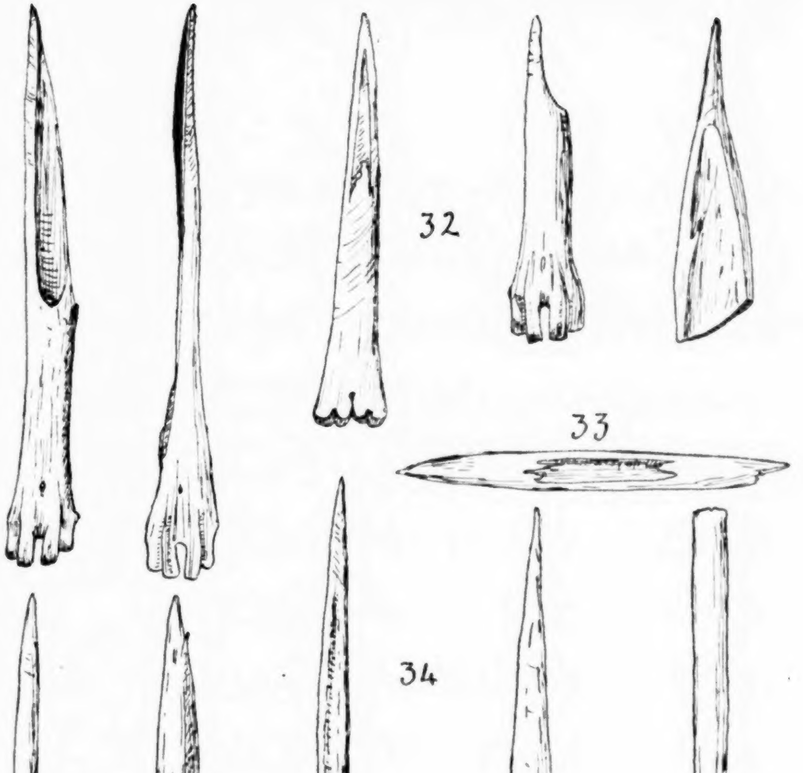
Much the same series of hammer-stones, some chipped, some slightly scarred and pecked, comes from this level. The pebble tools (fig. 41) are similar. At a depth of 1 foot from the surface portion of a split and broken bored stone of slate or shale (fig. 40) was found. The diameter is 7 cm. with a 1·8 cm. hole. The probable thickness was about 4 cm.

A fine large circular scraper (fig. 38) of smoky quartz, measuring 5 cm. in diameter, one or two stone crescents, and a few small circular ("thumbnail") scrapers make up the remainder of the stone implements.

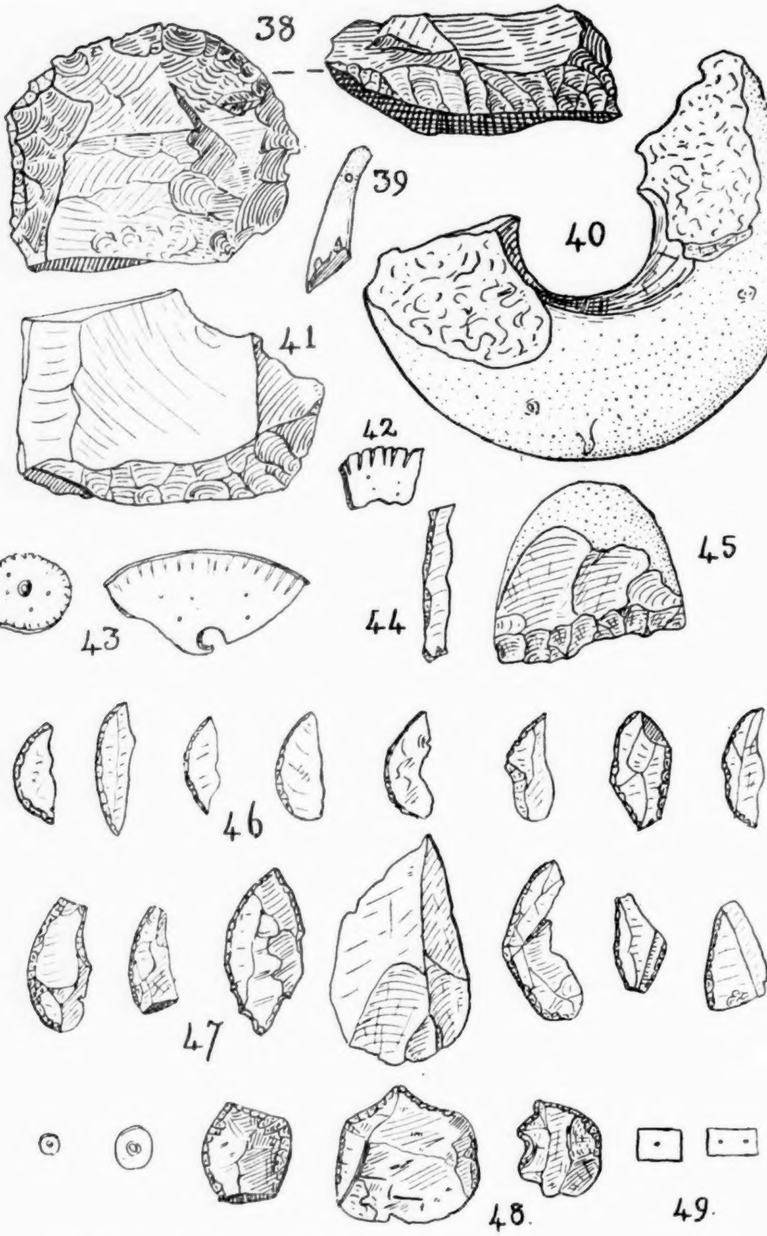
The shell and ostrich eggshell ornaments are much as usual (fig. 42), two spoon-like pieces of Turbo shell, a doubly bored eggshell oval with serrated edges, etc. Various Mytilus crescents and about one hundred ostrich eggshell beads were collected. A tooth, probably a lower front milk tooth of *Equus Zebra*, had been bored for suspension. No bone tools.

Layer 18–27 *inches* (figs. 43–45).

Much the same material. A broken fragment of an awl is the only tool of bone. The number of eggshell beads increases once again. Shell crescents abundant. One or two pebble tools.



FIGS. 32–37.—(Actual size.) Bone implements from layer 0–9 inches.



FIGS. 38-49.—(Actual size.) Figs. 38-42 from layer 0-9 inches. Figs. 43-45 from layer 18-27 inches. Remainder from Normal Wilton layer.

Layer 27–35 *inches.*

Material the same. A single bone awl, fragments of two more, with pieces of arrowpoints and linkshafts, are the only bone specimens. Shell crescents abundant. Fewer ostrich eggshell beads. An ivory peg, 4 cm. long, cut off square at each end, and tapering from 1·0 cm. to ·7 cm. diameter, is the only unusual find. An unbroken ostrich eggshell disc (resembling fig. 27) is from this level. No pebble tools recovered.

Test Layer 36 *inches* (figs. 46–49).

Three tests were taken in all, at depths of 34 inches, 35 inches, and 36 inches. An inch of material was sieved and sorted over a wide area. Of these tests the first two consisted of material identical with that in the 27-inch to 35-inch layer, and were therefore merged into that layer. The test at 36 inches proved more interesting.

Some thirty crescents, many of them very beautifully made, were recovered, and in addition six thumbnail scrapers (fig. 48). About half these implements are of white quartz (fig. 46), the remainder being of brown chalcedony (fig. 47). A few specimens of bead borers were found. Ostrich eggshell beads and a few fragments of eggshell, but no bone, shell or ivory tools, were recovered.

A fine pair of rectangular nacre beads was found with the Wilton material (fig. 49). They have been carefully squared. The one measures 7 mm. by 5 mm. and has a fine hole in the centre. The other is slightly longer and has two holes. Several ovals of cut Turbo shell come from this level, and these seem to represent the work of an expert in this material.

While it would be useless to suggest that the contents of this shallow Normal Wilton layer presents the full gamut of the local Wilton, it is at least representative and corresponds with the regional variation to be expected at such a site. It is sufficient to show that the Normal Wilton was represented in this shelter at this particular period.

The Smithfield C Material.

Immediately below the 36-inches test half a dozen Wilton crescents were found, and these certainly belong to the Wilton level. In addition it will be noted that three or four Wilton crescents, some identifiable as coming from the region of Grave VII, are found all through the Smithfield C deposit. In view of the vast numbers of typical Smithfield scrapers, these few elements are not important, and indeed may easily have formed part of the

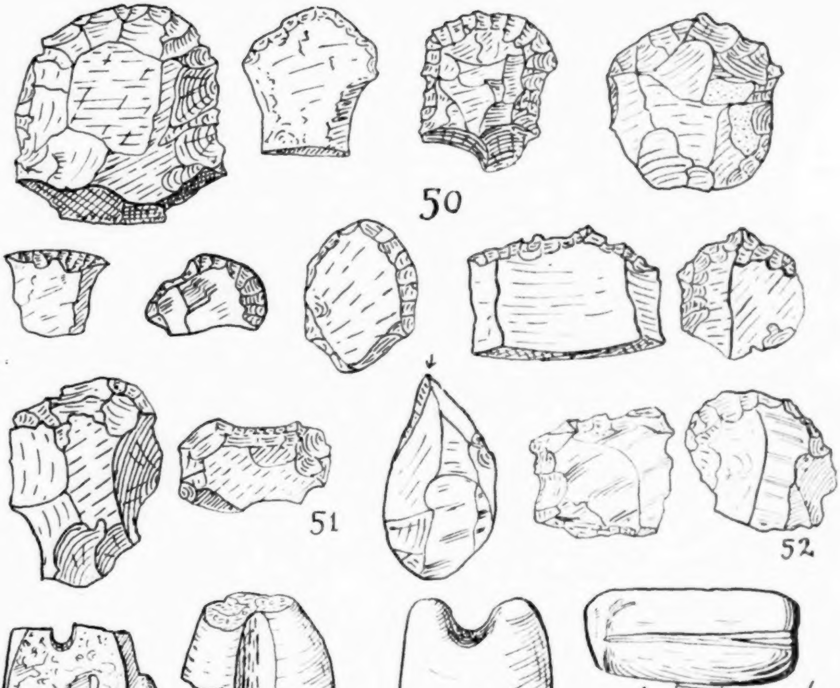
infillings of graves, infillings which I failed to isolate completely from stratified deposit.

The deposit from 36 inches to 54 inches (dropping to 60 inches in the regions of columns H and I) was excavated in suitable layers. 9-inch layers were used up to column H, and layers of 4 to 5 inches (roughly a decimetre) in columns H and I. There is little change observable in the size and type of the implements. The richness of this level is remarkable, more especially when we consider the extraordinary paucity of implement types. Throughout the whole deposit only implements of the general scraper type (end-scrapers, circular scrapers, thumbnail scrapers, etc.) could be recognised with certainty. There were over five thousand scrapers of white quartz collected from the Smithfield C deposit. Almost all specimens are in this material or in quartz crystal, and in a few cases (fig. 52) in surface quartzite. In addition there are some two hundred flakes of brown chalcedony, carefully used and showing a perfect cleavage, yet in only a dozen instances has any attempt been made to trim these into implements. The superior chalcedony was therefore known and used, but for some reason quartz implements occur almost exclusively.

From the vast numbers of quartz flakes found with the implements (forming almost a solid mass up to 2 feet in thickness), it is apparent that the shelter at this period was a workshop. There are certainly Mytilus shells in the upper 9 inches (36–45 inches), but they form a negligible portion of the whole deposit. In the underlying layers the diet changes to *Donax serra* almost exclusively, and still the proportion of shells to flakes is not high when we consider the usual midden deposit. In a workshop site such as this it is possible that the implements made from chalcedony were more carefully made, treasured, and removed. In no other way can we explain the presence of beautiful chalcedony flakes and the general absence of finished forms. The large numbers of quartz implements may then be the result of high wastage.

One other change in material will be noted. In the lowest level of the Smithfield C deposit in columns H and I (54–60 inches) the quartz used is almost a chalcedony, white and pearly, with a clean fracture, in contrast to that used elsewhere which shows a sugary fracture.

In dealing with the material in general the deposit of Smithfield implements south of column H has been treated as a single layer. It begins generally at 36 inches from surface, and rests on the buff-brown-buff deposit, which has been carefully isolated in the first paper of this series. The depth of the carbon "floor" or layer may be taken as the base of the Smithfield C deposit. As this represents a period of particularly fierce forest fire, we may presume that the cave was left by the earlier Smithfield B inhabitants (see below) from this cause.



FIGS. 50–62.—(Actual size.) Implements from the Smithfield C layers.

Deposit from 36–54 inches, south of Column H.

Stone.—Implements. End-scrapers, circular scrapers, thumbnail scrapers, and horse-shoe forms are abundant, and there are upwards of two thousand specimens from here. They vary in diameter from 4 cm. to 1 cm.; the great majority lie between 2 cm. and 3 cm. (figs. 50–52). In addition there are a few examples of winged scrapers. Detailed description of this group would be redundant. So far as the crudeness of the fracture of the more sugary quartz allows, they conform to the usual Smithfield C types. Four or five large flakes resembling Mossel Bay forms, some obviously flakes from river pebbles, others water-worn and therefore brought to the shelter, are the only important additional elements.

About thirty river pebbles show use as hammer-stones, and the ends are pitted and bruised. A few pebbles *écaillées* (obviously split hammer-stones) occur as well. Large numbers of discoidal artefacts in quartz, resembling the usual rather formless artefacts found in all industries, confirm the opinion that this was a workshop site. No pebble implements with trimmed edges are found.

Polished Stone.—Eight polished or ground stones come from the Smithfield C deposit. Six of these are from south of Column H and two from other parts of the excavation.

1. A grooved stone (fig. 53), 36 mm. × 24 mm. × 18 mm. Though the groove is regular it is too narrow to have seen use as a bead-stone. It is either a bone-sharpener or a bead-stone in the making. One end has been used as a hammer. It is important to note that there is a small carefully made nipple on one side.

2. A broken bead-stone (fig. 54).

3. A stone with a short groove across each end. The groove at the lower end (fig. 55) is natural, but appears to have been used, while the upper groove is artificial, though perhaps natural in its beginnings.

4. A bone-point sharpener, resembling fig. 53, but with a slighter grooving. The groove has bifurcated at one end (fig. 56). It bears a nipple similar to that on the other specimen.

5. Half of a broken stone bead (fig. 57). The original bead was acorn-shaped, bored longitudinally, and measured 23 mm. × 17 mm.

6–8. Three fragments of stone palettes. No trace of design.

The material used for numbers 1–4 is a hard black stone somewhat resembling slate in consistency. The bead is of a softer material resembling a grey soapstone. The palettes are of a soft greenish slate or shale.

Several fragments of red and orange ochres were found.

Shell.—Nacre ornaments. These are rare, and come generally in the upper 9 inches of deposit. No shell implements of Mytilus or of Donax.

Ostrich Eggshell.—In addition to large numbers of beads found throughout the deposit, a broken fragment of shell (fig. 60) was found. It bears numbers of carefully made, finely engraved, and roughly parallel lines. No further fragments of the shell were found.

Bone.—A single bone awl comes from this part of the deposit.

Deposit from 36–60 inches, Columns H and I.

Only the additional material is listed here.

36–40 inches. Five nacre ornaments (fig. 58). Three are the usual sections cut from Turbo shell, one is not bored. The other two are diamond-shaped pieces. The larger has a single hole bored in it towards one edge: the other is of heavier nacre (probably oyster), and has two holes and a serrated edge. This last is considerably worn from use. A bone awl (fig. 62). Four Mytilus crescents. A single ostrich eggshell.

40–45 inches. Six stone crescents, one shell crescent.

45–50 inches. Three stone crescents, two very perfectly made. Three Mytilus crescents. Three fragments of what appear to have been serrated scrapers, fragmentary and difficult to determine. Two nacre spoons, one bored, one with hatchings on the edge. A fragment of tube, $\frac{1}{2}$ inch long; the material is either the base of a porcupine quill or burnt bone. One bone awl (fig. 59).

50–54 inches. One badly made crescent of surface quartzite. A fragment of a serrated scraper. No bone or cut nacre.

54–60 inches. This is the richest part of the deposit. Upwards of two thousand implements, mainly scrapers of various types and discoidal artefacts, were recovered. There is a much higher standard of workmanship evident here, and this is to be associated with a different source of quartz supply. The quartz is much more chalcedonic in type. It is white and pearly with a very clean true fracture. The general size of these examples is somewhat smaller than the average from the overlying levels.

In addition to the usual forms, two crescents, a few beads, a bone arrow-point, and an ivory specimen (broken) were recovered.

The Smithfield B Material.

Columns B and C and column c were worked early at the lower levels to leave the remainder of the area clear while the graves were excavated. In this region the Smithfield B deposit may be said to lie between 60 inches and 77 inches from the surface. The value of the carbon layer became more and more evident as work continued, and therefore in the remainder of the deposit the depths are given from the carbon floor that lies between the two buff layers.

It is to be noted that there is no great difference to be observed between the general types of implements found below this floor and those found above. The variation is one of size, or more accurately a change in the distribution of sizes. While at the base of the layer immediately overlying the carbon floor the scrapers are generally small, averaging between 2 cm. and 3 cm., with a range from 1 cm. to 4 cm., this now changes. Below the carbon floor the range is from 2 cm. up to 6 cm. in the quartz specimens, while quartzitic sandstone examples are all much larger. The bulk of the material ranges from 3 cm. to 5 cm. in diameter. All implements are still of the general scraper family.

The deposit as a whole is far less rich than the Smithfield C layer, and represents perhaps the normal debris of a home site. The fine chalcedonic quartz material is rare, and the brown chalcedony is absent. The major part of the material is a white quartz with a sugary fracture. The proportion of quartzitic Table Mountain sandstone increases as we get deeper, and the deposit becomes poorer.

Columns B and C and Column c.

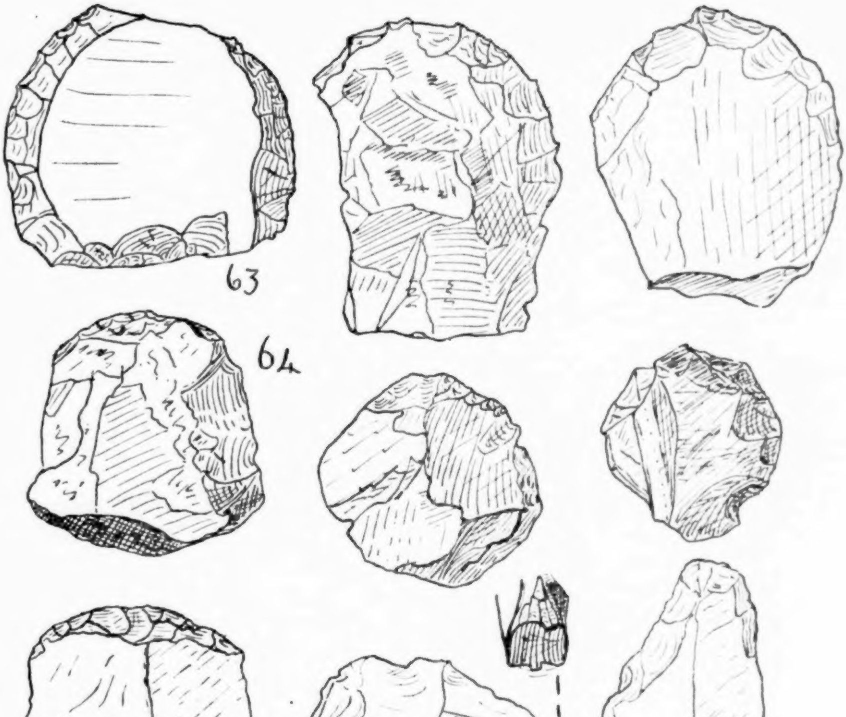
60–64 inches. One very fine scraper of surface quartzite (fig. 63) is from this level: two fragments of serrated scrapers, and the usual large end-scrapers and circular scrapers (fig. 64). A small ball of pink colouring matter, apparently a granitic clay, was found. No beads.

64–68 inches. One scraper of Table Mountain sandstone made on a pebble, in this layer, measures 10 cm. across. Three or four broken pebbles of the same material have been slightly worked. The sizes and general forms of the quartz implements are much the same as those in the layer above. No beads.

68–73 inches. The deposit is rapidly becoming poorer. The material is almost identical with that from overlying layers. The proportion of pebble material increases. Two pebbles have been halved and used as heavy fabricators or scrapers across the edge so formed. A badly made but typical Smithfield B end-scraper is of fossilised wood from the Tertiary Enon beds. A bone arrowpoint, some ostrich eggshell, and a fragment of a slate palette are from here. No beads.

73–77 inches. Not representative. We are getting towards the sterile part of the deposit. A good Smithfield B end-scraper (fig. 65) in quartzitic sandstone is from here.

Important additional elements from this layer are a Mossel Bay type of point (fig. 67) and a Still Bay type of implement (fig. 66). The point is of Table Mountain sandstone with a good faceted butt and typical Mossel Bay trimming. The other example is of chert. It has been shaped as a



Figs. 63–69.—(Actual size.) Implements from the Smithfield B layers.

small disc-core of the common Still Bay type, but at one corner a burin has been carefully made. Whether these two implements have been brought to the cave or were made and used here, they serve to date the whole of the overlying deposit as postdating the general "Cape Flats complex" in this region.

Columns D to G in Columns a and b.

A different system is here used to measure the depths of deposits worked. The carbon layer is regarded as a floor representing the surface of the deposit at the end of the Smithfield B occupation, which is marked by a forest fire. The exact depth of the floor below surface at any point can be got by referring to the table in Part I of this series. At the line G/H the depth varies from 52 to 57 inches.

Floor to 8 inches. The deposit is generally poor. Pebbles of Table Mountain sandstone are being used, and a few quartz scrapers of large size. A fine circular scraper in quartz crystal, recalling fig. 38, and various crude pebble tools are from this level. Near the Inner Cave the material is much the same, but there would appear to be some intrusion from the layer above, as the proportions of small scrapers and of chalcedonic quartz are higher than in the rest of the layer. There are a few ostrich eggshell beads, a fine "duckbill" type of end-scraper of quartz crystal, and a Still Bay disc (fig. 68) and a neat end-scraper of Table Mountain sandstone (fig. 69), in this section of the deposit.

8–18 inches below floor. Very poor. Smithfield B implements persist, with pebble flakes and rough pebble tools. One slate palette and a bone arrowpoint.

18–24 inches below floor. One or two good scrapers only. Two otoliths from sea-fish.

24–30 inches below floor. Very poor. Only a few good Smithfield B specimens.

30–36 inches below floor. Formal implements disappearing.

Underlying Material.

Scattered hearths with burnt bones and quartz split by fire or broken by man make up the remainder of the deposit down to the yellow layers of sand, which are sterile. No implement types could be recognised, and while there are suggestions of Middle Stone Age techniques on some of the flakes, these must be ignored as deduction from the sugary quartz used would be impossible to maintain. There is sufficient evidence to state that the shelter was made use of for a very considerable period before the Smithfield B deposit.

ARCHAEOLOGY OF THE OAKHURST SHELTER, GEORGE.

Part VII. Summary and Conclusions.

By A. J. H. Goodwin, M.A., F.R.S.S.Afr.,
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We may conclude the present series of papers by summarising the results of the excavation. This may best be done by tracing the history of the shelter from the beginning.

Underlying Deposit.

The cave may originally have been cut from the cliff face by the action of the stream which now runs some twelve feet below the base of the deposit. If this was so the layers of sand forming the sterile floor of the cave, and resting upon bare rock, were deposited by the action of the stream in spate. After this period there accumulated some thirty inches of compacted sand and clay, containing a high proportion of lime. The whole accumulation is marked by scattered hearths containing carbon and burnt bones of animals. Throughout this portion of the deposit are numerous broken and splintered fragments of quartz; some have been broken by man, some by fire. The deposit thus shows that at this period the cave was being visited by man. No cultural elements are recognisable, but it may be suggested that the period covered by this lower deposit includes part of the Middle Stone Age. The reason why the shelter was not used as a home at that period, lies in its openness to the weather.

Middle Stone Age.

It is the presence of a few specimens of Still Bay and Mossel Bay implements in the earliest fully inhabited layers which suggests that the relatively sterile lower deposits cover part of the Middle Stone Age. These elements are sufficient to prove that the whole overlying deposit is later than the general "Cape Flats complex." *

Smithfield B.

Overlying the poorer layers containing hearths is a deposit some thirty inches deep, containing Smithfield B implements in quartz. At first Smithfield B man was only a visitor like his predecessors, then later, as

* See Goodwin, A. J. H., The Cape Flats Complex, S. Afr. Journ. Sci., xxx, 1933, pp. 515–523. Illust. Also, Goodwin, A. J. H., Chronology of the Mossel Bay Industry, S. Afr. Journ. Sci., xxvii, 1930, pp. 562–572. Illust.

the cave floor rose and the shelter provided more protection, he made his home here. Pebble implements, made on pebbles broken across, start strongly. The midden is heavy, and consists mainly of Oyster and Razor (*Solen* sp.) shells. The pebble implements disappear towards the top of the Smithfield B. Fish-bones have not survived, but two otoliths from sea-fish, both burnt, suggest that fish were eaten, though the means of catching them were inadequate.

Smithfield C.

In general a change is seen in the Smithfield C deposit. At the base are regular piles of *Donax serra*. There are still few fish-bones. In the upper deposit the meal-piles of *Donax serra* give way to crushed and broken Mytilus, without shell crescents. There is no reason to presume a change in the sea fauna, as all these shells are common to-day. The cave-dwellers more probably changed their source of supply.

The Smithfield C material actually presents little change from the Smithfield B, save in the general size of the implements, the absence of pebble forms, the appearance of polished and grooved stones, the increased use of eggshell beads, and so on. The important differences lie in the change in the implement sizes, and in the presence in phase C of the new elements which will be seen to persist through the Wilton period.

The Smithfield C deposit is remarkably rich in flakes and scrapers, but just as remarkably poor in implement types. It is to be observed that this is a workshop site, and the implements do not necessarily present the Smithfield industry in its true proportions. The one deduction we may reasonably make is that the vast numbers of flakes and scrapers encountered at this level belong to a single phase of a single culture, a quartz variant of the Smithfield C. The presence of a few specimens of Mytilus and stone crescents must be ignored in view of the disturbance of the deposit by burials.

The ornaments recovered from this level were generally from the top of the Smithfield C deposit, and they are sufficiently like the Wilton types for us to presume that they mark either the beginning of Wilton influence or that they are a normal step in the evolution towards the Wilton.

The "protection-fire" noted on our fourth visit is interesting. It begins at a depth of about 45 inches, and continues to the surface. It divides the shelter into two parts longitudinally. The inner and more protected part has Zostera (sea-grass) and unbroken shells, suggesting that the cave-dwellers slept behind the fire. In front of the fire the shells are crushed and Zostera is absent. It is likely that the protection-fire is related to the ash-heaps encountered on our third visit at the southern end of the

shelter. They suggest strongly that the cave-dwellers heaped their ashes much as the present-day Naron do.

Normal Wilton.

Immediately overlying the Smithfield C is a shallow deposit of Normal Wilton. It is not rich compared with the vast agglomeration of Smithfield C material below, but it is distinct and provides proof that the more common Wilton of the uplands was represented in this shelter at that time.

Developed Wilton.

Overlying the Normal Wilton is a Developed Wilton, a deposit three feet in thickness. It is typified by large numbers of Mytilus crescents. Stone crescents are still to be found, but they decrease markedly. This continues to the cave floor.

The cave deposit generally is looser above the Normal Wilton layer, and it is obvious that from that period the shelter became drier. The underlying layers seem to have suffered from the effects of water, and we must therefore regard the Developed Wilton deposit of about 36 inches as short in comparison with the underlying 36 inches.

Throughout the Developed Wilton the basis of subsistence is mainly shell-fish, fish, and animals. All are of modern type and have been listed. At the Wilton level begins a marked increase in fish-bone, suggesting that efficient means of catching fish had been evolved. A second change occurs at about 18 inches, where there is an increase in pebble tools. These types are to be found in the underlying layer (18 inches–27 inches) but the increase now becomes marked. There is a contrast between these pebble tools and those of the Smithfield B phase here. The Smithfield B forms are made from pebbles broken across, while the Wilton tools are generally scrapers made on split pebbles or on flakes struck from pebbles. There are in addition various small grinders, and pebbles broken in use.

Pottery.

Finally there is the sudden appearance of pottery, accompanied by a reappearance of bone tubes, and an increase in bone arrow-heads and awls. This is confined to the uppermost part of the Developed Wilton layer.

The pottery has been identified by Mr. J. Schofield as "Hottentot." Possibly this is to be attributed to a contact of peoples, a cultural contact, or even to trade. There is no evidence that these people kept cattle, and no teeth or bones of the domestic ox were to be found. It is evident that the pottery is a completely new cultural element without any precursor at the Oakhurst shelter.

CONCLUSIONS.

In general certain points of importance arise from our study of this shelter. We have a general sequence:

Pottery.
Developed Wilton.
Normal Wilton.
Smithfield C.
Smithfield B.
Cape Flats complex.

But in addition to that sequence we have two types of "pebble culture," the one associated with Smithfield B, the other with Developed Wilton. We have a midden culture with little fish which suddenly changes to a fish-eating subsistence with the Wilton period. We eventually find that fully evolved pottery of an advanced type can be adopted quite happily by the Developed Wilton people without much other cultural change.

In addition certain important continuities are to be observed. There is no very decided break between Smithfield B and C. The first change observable is that where large scrapers are present in the B phase, these are replaced (though not completely) by very much smaller forms. The pebble implements meanwhile die out. Throughout the two Wilton phases the small scraper persists. With the Normal Wilton crescents occur, and persist through the Developed Wilton, while Mytilus crescents in any number are found only in the Developed Wilton. It is to be noted too that there is no great change in the physical types represented throughout.

The most important lessons this shelter teaches are that there is a quartz variation of the Smithfield present at our coastal sites; that our cultures are not isolated zoological species, but may mix and mingle, develop and borrow, quite freely. We also learn that the paucity of stone implements at our midden sites may well be associable with a great increase in shell tools.

My thanks are due to Mr., Mrs., and Miss Dumbleton of Oakhurst for their constant and willing help in everything which has had to do with this excavation; to the University of Cape Town for a grant-in-aid of one of my visits; to the South African Museum for their general help; to Dr. Haines, Mr. J. G. Taylor, Miss M. Nichol, Mr. B. D. Malan, and Mrs. Bowler Kelley for help on various visits; and to Dr. M. R. Drennan and Mr. J. F. Schofield for their ready collaboration.

AN UNUSUAL GROOVED STONE.

By P. W. Laidler, F.S.A.Scot., F.R.A.I.

(With one Text-figure.)

(Read April 21, 1937.)

This stone was ploughed up at Flaauwkraal near Aliwal North by Mr. J. H. B. Coetzee, who generously presented it to the author.

It is formed out of a piece of micaceous sandstone which has been worked down by scraping to its present shape, three and a quarter inches long, one inch and eight-tenths at its broadest, of oval section at mid-length, and tapering towards either end. The main groove on what will be called the upper surface is three-sixteenths of an inch deep and five-sixteenths of an inch broad, and its axis is not horizontal, but dips towards either end of the stone. On section the groove is U-shaped. On either side of the stone is a slight longitudinal groove, the deeper of which is indicated by longitudinal striae.

The unique feature of this stone is its longitudinal perforation. At either end is a shallow cone-shaped depression similar to that frequently found on perforated digging-stones. This is five-tenths of an inch in diameter. The perforation is three-tenths of an inch in diameter at the one end, seven-twentieths at the other. Half-way along it is a circular

rough ring where the partition between the borings from either end was broken away, with many deep longitudinal scars the result of this operation and of trimming. The diameter of the perforation at this point is slightly less than the diameter at either aperture. More pronounced at one end than at the other is a subsidiary groove, which bites into the outer wall, the result of suspension of the stone by means of string or reim passed through the perforation.

The only similarly shaped perforated stone which appears to be recorded is that ungrooved stone of soft talc serpentine, of eppipsoidal shape, 5·4 inches long, breadth at centre 2·5 inches, and thickness at centre 2·0 inches described by Father Stapleton in the South African Journal of Science, 1935. His specimen was found near Salisbury, S. Rhodesia. Both ends are broken off: its whole surface is covered with deep striations, and the perforation is stated to be by drilling. Its recorder believes it to be a net sinker. Did primitive people ever take so much trouble over a net sinker? Have nets ever been used by primitive people south of the Zambesi?

The explanation appears to lie in the Flaauwkraal specimen, which is an ostrich egg-shell bead polisher. The common "**U**" grooved bead polishing stone and the "**V**" grooved awl or arrow sharpener are well known. Specimens in which the stone has been worked or pecked into shape before being grooved are less common. The two specimens described above appear to be the only recorded perforated stones of this type, and the method of their perforation is of particular interest, and this can be described in detail from the author's specimen.

Though the shaping of the stone's outer surface was simple, even with only stone chips available and though digging-stones could be perforated by reaming and pecking with stone chips, the length and narrowness of this perforation suggests the use of a longer, tougher, less brittle substance. In the Flaauwkraal specimen there is no sign of rotary boring by means of stick and sand, and the examination of a large number of bored stones and pipes suggest that this method was rarely used in South Africa, and never by the bushman. It appears, in the Flaauwkraal specimen at least, that boring was performed with a rod of metal by chiselling and pecking, a suggestion that is strongly supported by the deepness of the longitudinal grooves formed by the breaking down of the partition between the two bored holes.

A DESCRIPTION OF THE POTTERY FROM THE UMGAZANA AND ZIG-ZAG CAVES ON THE PONDOLAND COAST.

By J. F. Schofield, A.R.I.B.A.

(With one Text-figure.)

(Read April 21, 1937.)

Introduction.

The numbers, the varieties, and archæological importance of the implements in bone and worked stone discovered during the excavation of the Umgazana Cave on the Pondoland Coast was so great that they completely eclipsed the much less sensational finds of fragmentary pottery which were made throughout the upper half of the stratigraphical material, the more so since it was seen from the first that while the implements of bone and stone belonged to a single cultural horizon, the pottery was clearly an intrusion from another field. Nevertheless, it is very important that all finds of pottery that are made in conjunction with material from other and earlier cultures should be fully described, particularly when the stratigraphy of the deposits has been so well established as in the case under review.

The pottery, which it is our purpose to describe, was obtained from the Umgazana and Zig-zag Caves on the Pondoland Coast, near Port St. John.

The Umgazana Cave.

This cave has been most carefully described by Chubb, King, and Mogg in "A New Variation of Smithfield Culture from a Cave on the Pondoland Coast," published in these *Transactions* in 1934. These notes must be considered as an addendum to that paper.

Description of the Pottery.

The pottery discovered is illustrated in Nos. 1 to 4 of the text-figure. It is entirely hand-made, and unfortunately so fragmentary that it is impossible to reconstruct any single piece with the exception of the large

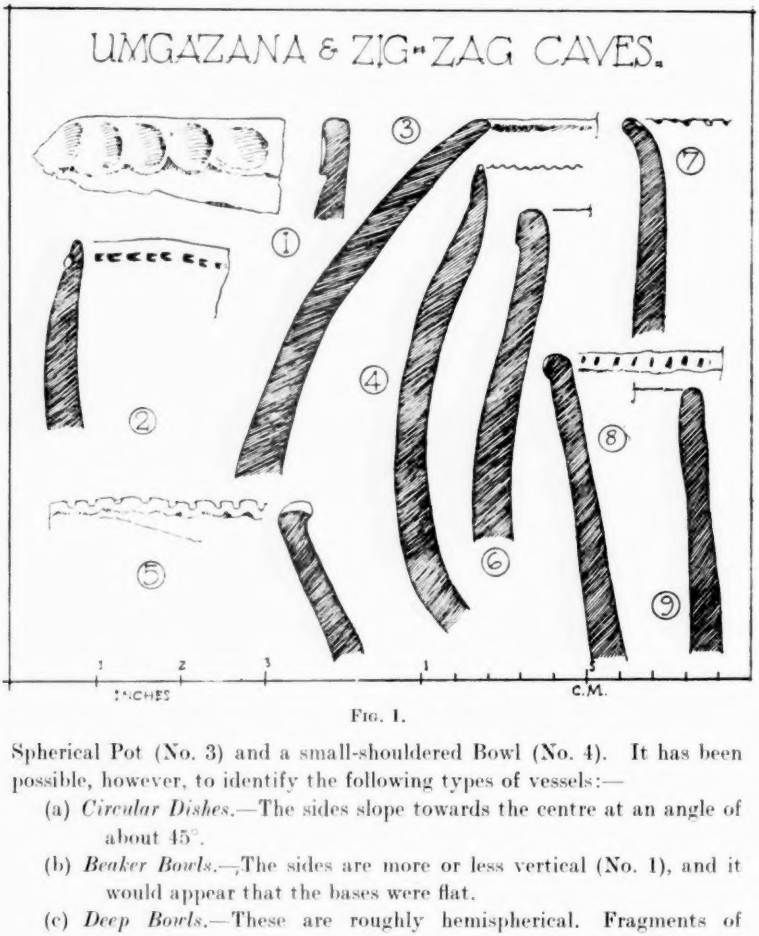

Fig. 1.

Spherical Pot (No. 3) and a small-shouldered Bowl (No. 4). It has been possible, however, to identify the following types of vessels:—

(a) *Circular Dishes.*—The sides slope towards the centre at an angle of about 45°.

(b) *Beaker Bowls.*—The sides are more or less vertical (No. 1), and it would appear that the bases were flat.

(c) *Deep Bowls.*—These are roughly hemispherical. Fragments of several bowls were found, varying from 6 to 13½ inches in diameter.

(d) *Shouldered Bowl.*—The only one taken is that figured in No. 4.

(e) *Spherical Pots.*—These appear to have been of large size and similar in every way to modern wares.

The pottery is exceedingly rough, but some attempt has been made to obtain a smooth surface. Two pieces (Nos. 1 and 2) show traces of having been blackened externally. The clay of one piece (No. 1) is very sandy, but there is nothing to distinguish the remainder from wares found on other coastal sites in Natal.

Discussion.

This pottery does not accord exactly with any known industry, the Beaker Bowls with flat bases have never been published, but are very similar to pieces from Mapungubwe.

The most interesting piece is the fragment of the rim of one of these bowls (No. 1). In this the rim has been tapered and then doubled over and pressed down with the thumb. Although this exact motif has apparently never been noted before, a very similar technique has been described in ware from Umhloti by the writer, and classified as NC_2, which would fit our piece equally well ("Natal Coastal Pottery," S. Afr. Journ. Sci., vol. xxxii, p. 518, fig. 2, No. 2).

The remainder of the pottery has several features which conform to Class NC_2, and modern Pondo pottery, such as the notched edge (No. 4), the stylus impressions (No. 2); and we consider, therefore, that it should be included in that class.

We have been unable to find any trace of Hottentot influence in this pottery, the characteristic internally reinforced lugs, the thin well-burnt ware, and the ovoid forms are conspicuously absent.

The Zig-zag Cave.

The deposits in this cave consist mainly of shell midden about 2 feet 9 inches in depth. Throughout the mass of this, animal bones and pottery were found to be distributed. Near the surface, at the back of the midden, a skeleton, of which the cranium was unfortunately missing, was found to have been buried.

The pottery is illustrated in Nos. 5 to 9 of the text-figure; the types are similar to those from Umgazana but with greater preponderance of beaker bowls, some of which were of large size. The rim (No. 6) is exactly similar to pottery from the Durban district. We have therefore classified this pottery also as being NC_2.

The wooden pegs, stone implements, and bone tools, which were such striking features of the Umgazana Cave deposits, are entirely lacking in this cave. A number of seemingly human flakes were taken throughout the excavation, but none of these showed signs of use or of secondary trimming, nor did any of them belong to a recognised industry.

General Discussion.

The deposits in the Umgazana Cave have been divided into 30 strata (Diagram III. U.C.), the pottery being found in those numbered 14 to 26 inclusive. Now since stone implements were found in strata 2 to 28, and

bone implements in strata 4 to 24, it is clear that pottery did not form a part of the original cultural complex of our shore-dwellers.

We cannot suppose that the pottery was evolved by them because it appears in a fully developed form, and the rim illustrated (No. 1) was amongst those found in stratum 14 and shows a more advanced technique than any other piece taken. This, coupled with the fact that several of the beaker bowls are of large size, and therefore difficult to make, indicates that all of the pottery is the work of a people who were expert potters with a long tradition of ceramics.

We learn from Perestrello's account of the wreck of the *Benedict* that in 1554 the country near the Infante River, which we take to be the Umtata, was occupied by "Kaffirs." "The Kaffirs," he says, "are very black in colour, with woolly hair"; further, he tells us, they were "armed with many wooden pikes, with their points hardened in the fire, for these are their principal arms, and some assagais with iron points." Near the site of Port St. John the country "was thickly populated and provided with cattle," the "language of these Kaffirs was not badly pronounced."

We must therefore conclude that the Port St. John district was then occupied by people practising the primitive agriculture and cattle-herding which we associate with the Bantu, but without their knowledge of iron-smelting, although a certain amount of that metal was in use, as is shown, not only by the pottery, but by the presence of pointed wooden pegs in the Umgazana deposits, which had evidently been sharpened with a metal knife.

Sixty-eight years later the survivors of the *Joao Baptista* found the conditions much the same, except that the Kaffirs were well armed with iron assagais. It would appear also that the limit of the Bantu occupation was then not far to the south-west of Port St. John, beyond which lay a desert twenty days' journey in width, which had to be crossed before the Hottentot outposts, near East London, were reached.

Such conditions would fit very well the material from Ziz-zag Cave. The absence of ox bones from the debris does not invalidate this conclusion, as they are not found in the middens near Durban, which yield pottery in every way similar to that from inland sites where ox teeth have been taken in quantities.

From the analogy of these middens it seems very probable that these shore-dwellers were actually the makers and users of the pottery which we have elsewhere classified as NC_2. In culture they were probably Sotho, and by blood Bantu Bush, or Bush-Bantu.

The Umgazana Cave represents an earlier condition before the Bantu occupation had driven as far south as the Umzimvubu, but was near enough for its influence to be felt, and for the late Stone Age folk to obtain Bantu

pottery and iron knives by fair means or foul. On the other hand, these deposits in which pottery occurs may be due to a band of Sotho living with these folk on terms of the closest intimacy.

From the foregoing it will be seen that we date the material from the Zig-zag Cave to approximately the middle of the sixteenth century, while that from Umgazana is probably earlier.

Conclusions.

We find that this pottery has none of the characteristics of Hottentot pottery. On the other hand, it has features, such as the notched rims, in common with pottery from the Zeerust district, modern Pondo pottery, and the wares we have elsewhere classified as NC_2. As the nearest counterpart to the large beaker bowls is to be found amongst the pottery from Mapungubwe, in the North-Western Transvaal, we include our pottery with these others, and consider that all are to be attributed, more or less directly, to the Sotho tradition. This is confirmed by the discovery elsewhere of Sotho pottery in conjunction with stone implements in cave deposits, and also by the accounts of the Sotho themselves, which have been published by Ellenberger, and bear witness to the intimate relations which existed, down to recent times, between the Sotho and the Bush peoples.

Class NC_2 pottery is associated with an iron-using, rather than with an iron-smelting, phase, and this accords well with the pointed wooden pegs from Umgazana, and the absence of iron and iron slag from both these caves.

The pottery from the Umgazana Cave is to be dated as probably being before the middle of the sixteenth century, and that from the Zig-zag Cave as being probably subsequent to that period.

DESCRIPTION OF TEXT-FIGURE.

1. Probably a fragment of the rim of a Beaker Bowl with nearly vertical sides, 13½ inches over the rim, in a sandy ware, burnt to a brown-grey, finished with a rough surface, blackened externally. The rim was tapered and folded over on to the outside, and decorated with the impressions from the pulp of the thumb.

From Stratum 14, Umgazana Cave.

Probably Class NC_2.

2. Fragment of a Bowl, 13½ inches over the rim, in a grey ware with a light grey surface which is smooth and blackened externally. The rim is tapered, rounded and decorated externally with a line of deep impressions made with a small bone or similar object.

From Stratum 26, Umgazana Cave.

Probably Class NC_2.

3. Fragment of a Large Spherical Pot, 8 inches over the rim, 13½ inches in diameter, and about 12 inches deep. In a coarse black ware finished smooth at the surface. The rim is rounded.

From Stratum 24, Umgazana Cave.

Class uncertain.

4. Shouldered Bowl, 5¾ inches over the rim, 7¾ inches in diameter, and about 7 inches deep. In a coarse black ware, finished smooth. The rim is tapered, rounded, and notched.

From Umgazana Cave.

Class NC_2.

5. Fragment of a Shouldered Pot or Beaker Bowl, 10½ inches over the rim, in a coarse blackish ware, finished smooth. The rim was rounded and burred on the outside, the edge was decorated by pressing a small stick or similar object into the wet clay.

From Zig-zag Cave.

Class NC_2.

6. Similar to the last, 15 inches over the rim, in a coarse grey ware, burnt to a grey-brown at the surface, which is slightly smoothed. The rim has been rounded and finished on the outside with a narrow projecting fillet.

From Zig-zag Cave.

Class NC_2.

7. Beaker Bowl, 20 inches over the rim, in a coarse dark grey ware, the surface partly smoothed. The rim was rounded and slightly everted, and decorated on the interior aspect with an irregular line of notches.

From Zig-zag Cave.

Class NC_2.

8. Fragment of a Beaker Bowl, 12½ inches over the rim, in a coarse blackish ware, smooth at the surface. The rim has been rounded and burred on the outside, which is decorated with small cuts at irregular intervals. The sides slope outwards, and the face was probably flat.

From Zig-zag Cave.

Class NC_2.

9. Beaker Bowl, 16 inches over the rim in a very coarse dark grey ware roughly finished. The rim is simply rounded.

From Zig-zag Cave.

Probably Class NC_2.

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THE ODORIFEROUS GLANDS OF SOME SOUTH AFRICAN HARVEST-SPIDERS.

By R. F. Lawrence, Ph.D., Natal Museum, Pietermaritzburg.

(With Plate IX, and three Text-figures.)

(Read May 19, 1937.)

Comparatively little is known about the odoriferous glands of Opiliones in general, and only one mention has been made in the literature of their function in South African forms. A good historical summary of our knowledge of these glands up to 1904 has been given by Hansen and Sörensen (1904); part of the following historical account has been adapted from this paper.

The earliest mention of some Opiliones being remarkable for a peculiar smell is made by Latreille (1804) of *Phalangium* (Palpatores); he, however, took the openings of the glands for a second pair of spiracles. It was long before naturalists obtained a clear knowledge of the glands which secrete the smelling substance. Treviranus (1816), Tulk (1843), and Leydig (1862) mistook them in the common harvest-spider for eyes. Gervais (1849), with regard to Laniatores, stated that these organs were odoriferous glands, but this statement was overlooked by Krohn, who, examining these organs in 1867, found that they were glands, without, however, recognising their special function. Thorell (1876) used the positions of the gland-openings as a character for distinguishing genera within the suborder Palpatores. Simon (1879) expressed the opinion that they were special organs secreting an odoriferous liquid peculiar to harvest-spiders, and adds "plusieurs possèdent aussi, comme moyen de défense, un liquide odorant excrété par les orifices latéraux dont nous avons parlé; chez le *Phalangidium Opilio* cette odeur rappelle celle du brou de noix." In the same year Sörensen showed that these organs in Laniatores are odoriferous glands, and often secrete a liquid of a strong yellow colour caused by small drops of oil held in suspension, having a sharp odour reminiscent of horse-radish, which irritates the eyes of an observer examining the animal with a hand-lens. Loman (1881) was undecided as to the function of these glands in the family Phalangioidae (Palpatores), though acquainted with Sörensen's anatomical investigations in Laniatores. Rössler (1882) stated that *Opilio albescens* (Palpatores) disseminated an aromatic smell. The accounts of

Simon and Sörensen, taken in conjunction with the observations of previous authors, thus leave very little doubt as to the function of these glands throughout the whole order of Opiliones, which is that of defence.

Since Hansen and Sörensen's work in 1904 very little that is new has been added to our knowledge of these glands, the statements of various authors tending for the most to confirm the impressions of the older ones. Bristowe (1924) thus notes that in some members of the Gonyleptidae from Brazil "a strong and rather sweet odour is produced." Stipperger (1928) collected many hundreds of harvest-spiders but was only able to record a smell on one occasion, when a specimen of *Gyas titanus* gave out an offensive odour which lasted continuously for two minutes. Kolosvary (1929) stated that when harvest-men (*Phalangium cornutum*) were placed in a tube containing ammonia or alcohol vapour there was strong secretion in the form of drops at the openings of the glands. Secretion also followed a mechanical stimulus, such as grasping the animals. He came to the conclusion that the secretion in the first instance was used to neutralise the irritant effects of the chemical substances. Iodine vapour and volatile perfumes brought about the same effects in these harvest-spiders, except that they produced in addition symptoms of stupefaction. The secretion mingled readily with tincture of iodine, and in Kolosvary's opinion the substances are probably allied.* Kästner (1935) handled very many specimens of the common European harvest-spider, examining them under a binocular microscope without becoming aware of any smell or liquid secretion in the neighbourhood of the gland-openings.

The only mention of these glands in South African harvest-spiders is that of Hansen and Sörensen (1904, p. xi) in which Dr. W. F. Purcell's observations on *Purcellia illustrans* (Cyphophthalmi) from Cape Town are recorded in the following words: "Some years ago Dr. Purcell told one of us that a small form belonging to the Opiliones (when irritated) ejected a liquid through 'a short tube resembling strongly an eye stalk' and situated on the side of the cephalothorax."

The External Structure of the Gland-openings.

Larifugella natalensis.—Most of the observations contained in this paper were made on Laniatores, and the species used most frequently was *Larifugella natalensis*, common in the neighbourhood of Pietermaritzburg. It is, therefore, advisable in the case of this species to give a brief account of the external appearance of the gland-openings and the structures in their

* A maceration of the anterior halves of the carapace of 8 specimens of *Larifugella natalensis* was tested by Professor R. B. Denison, of the Natal University College, Pietermaritzburg, for inorganic iodine. The test was negative.

immediate proximity. These structures are also compared with two allied species on which observations were made, *Adaeulum rubustum* and *Larifuga capensis.*

If one of the antero-lateral angles of the carapace of *L. natalensis* is looked at from above, a slit-like opening will be seen between the margin of the carapace and coxa II (fig. 1). This slit is not, however, the opening

FIG. 1.—*Larifugella natalensis.* Anterior margin of carapace and coxa II from directly above, showing the slit-like openings of the odoriferous glands.

of the gland itself, but leads from it into a vestibule outside the real opening. The opening of the gland is concealed by the coxa of leg II, which is much larger than that of leg I, and is armed on its posterior margin with some coarse conical granules. On the dorsal surface of coxa II is a very large flattened tubercle placed transversely to the long axis of the segment and very close to the margin of the carapace (fig. 2, *a*); this tubercle, together with that portion of the carapace immediately opposite to it, forms the slit mentioned above. This structure is not found in the other coxae, and thus the junction of carapace and coxa forms a slit only in the case of the second leg; this opening is presumably of constant width as the coxa is immovable, or almost so. There is, in addition to the large blade-like tubercle, a smaller subsidiary tubercle anterior to it, which curves round, touching the margin of the carapace, and forming an anterior boundary to the vestibule (figs. 2, *a* and 3, *a*).

The large blade-like tubercle, projecting upwards and overlying the lateral border of the carapace, forms the lower margin of the so-called vestibule, the upper margin consisting of a series of granules, the largest

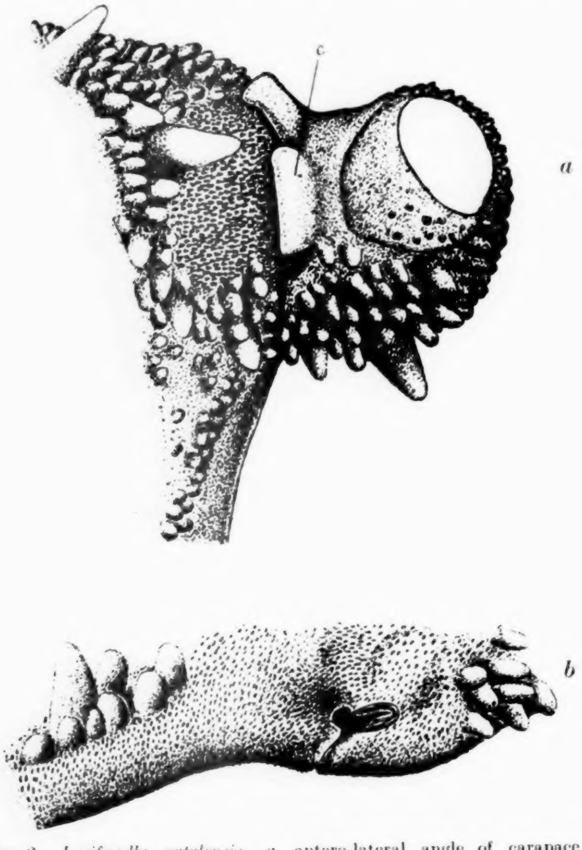

FIG. 2.—*Larifugella natalensis.* *a*, antero-lateral angle of carapace and coxa II seen from above and more from the side than in text-figure 1; *t*, blade-like coxal tubercle; *b*, opening of odoriferous gland from the side.

of which is a group of three at the antero-lateral angle of the carapace (figs. 1 and 2, *a*). The central one of the group is the largest of all the granules on the dorsal surface and projects over the vestibule, forming with the rest of the series of granules a roof-like covering for it (fig. 3, *a*). The vestibule itself is semicircular, and quite smooth as compared with the rest

of the dorsal surface of the carapace. Seen under low power of the microscope it has a shagreened appearance, due to being uniformly covered with fine equal-sized spicules (figs. 1 and 2, *a*). The inner surface of the blade-like tubercle of the coxa which abuts on the vestibule is also covered with these fine spicules (fig. 1). The actual gland-opening is only visible when the whole of coxa II is removed; it lies opposite the anterior margin of coxa II, a little above the edge of the carapace, though it appears to be situated more on its under surface than near the edge itself, the rim of the carapace being turned downwards and a little inwards. The opening is minute, comma-shaped, and provided with a small suture, which forms a groove leading backwards and downwards from its posterior end (fig. 2, *b*).

The large granules at the antero-lateral angle of the carapace and the rim-like tubercle of the second coxa evidently serve as a means of damming the liquid secretion of the gland and preventing it from running away towards the under surface of the body. The smooth surface of the vestibule with its covering of fine spicules causes the drop of secretion to adhere in its entirety to the carapace instead of flowing over its rough and irregular surface.

Adaeulum robustum.—The external structure of the gland-opening is in general the same as in *Larifugella natalensis*; the vestibule, however, is not by any means as clearly defined, there being no overhanging granules above it at the antero-lateral angle of the carapace; the enlarged transverse tubercle of coxa II is much smaller, and there is an anterior and posterior subsidiary tubercle enclosing the slit-opening before and behind. The vestibule itself is smaller and is only distinguished from the surrounding areas by its marked smoothness; both it and the opposing surface of the coxal tubercle are covered with fine spicules. The actual opening of the gland has much the same appearance as that of *L. natalensis*, but is situated either on the edge itself or a little to the upper side of the carapace.

Larifuga capensis.—The structure of the vestibule is very similar to that of *Larifugella natalensis* except that the bordering granules, especially the large antero-lateral one, are much less prominent, and the vestibule is thus not so sharply marked off from the surrounding parts of the carapace. The large transverse coxal tubercle is almost identical with that of *L. natalensis* in shape and size. The position and appearance of the actual gland-opening is almost exactly similar to that of *L. natalensis*.

There are no ascertainable differences in the sexes with regard to these structures in any of the above-named species.

Secretion of the Odoriferous Glands.

Laniatores.

Family *Triaenonychidae.*

The observations forming the basis of the following account were made on two species of large-sized Triaenonychinids, *Larifuga capensis* from Cape Town, and *Larifugella natalensis* from Pietermaritzburg. In both cases only adult examples of both sexes were used, 12 of the former species and 38 of the latter.

Secretion was stimulated by pressure applied to the carapace either with a pair of forceps or with the fingers. In no case was there failure to secrete, though the amount of secretion varied considerably among different animals. In order to photograph the secretion, the legs were firmly fastened to a glass plate with plasticene (Pl. IX, fig. 2), and pressure was then applied. In some specimens the liquid only appeared after long and considerable pressure, in others almost at once. As the stimulus was increased, a small round bead of liquid appeared at the slit-opening referred to above, sometimes forming rapidly, at other times commencing as a minute speck and growing gradually larger. This bead appeared either on one side of the body only or on both sides simultaneously, more usually the latter.

The bead was always conspicuous, with a very shiny appearance rather like that of a miniature rubber balloon; this impression was heightened by the fact that it was sometimes seen to increase or decrease in size as if part of the secretion was being alternately expelled and withdrawn into the gland-opening. The colour of the liquid was always a vivid yellow at first, though sometimes, after the animal had secreted a second or third time, it became a lighter cream or dirty white. The drop of liquid, after its appearance, persisted for some time, retaining its original shape, so that a photograph could be made. After a longer period the drop disappeared, having either evaporated or become resorbed into the gland. The amount of liquid secreted was considerable, taking into account the small body-size of the animal. While waiting for the formation of this bubble of liquid with a hand-lens, a fine jet of liquid from the gland was often observed, reaching to at least an inch above the carapace in a slightly backward direction (fig. 3, *b*). This backward projection of the liquid may have been due to the fact of the stimulus having been applied to the carapace behind the glands, and it is probable that the animal has some control over the direction in which ejection takes place. Perhaps the large coxal tubercle referred to, by being pressed against the gland-opening, plays some part in this control. This ejection was noted in numerous instances after pressure stimulation, while in one case it was observed after the legs had been secured with plasticene for photographing when an ant happened

to walk over the dorsum of the animal. In one or two cases it occurred merely while the legs were being secured with plasticene, the trunk of the animal not having been touched. (Fig. 2 of Pl. IX shows the mark left by a droplet of the secretion on the glass plate.)

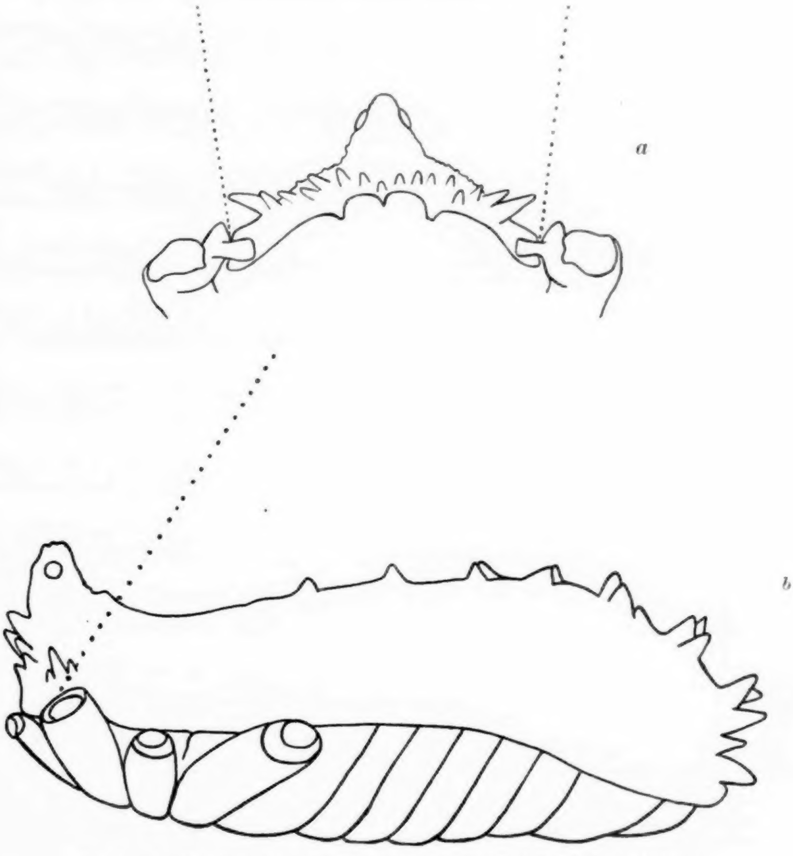

Fig. 3.—*Larifugella natalensis*, showing the angle at which fluid is ejected from the gland-openings, *a*, when seen from in front, *b*, from the side.

Immediately on the appearance of the droplet of liquid a very definite odour could be detected. In the case of *Larifuga capensis* the odour strongly resembled that of iodoform; in the case of *Larifugella natalensis* it was an acrid and rather unpleasant smell, which may be described as

rather like, though not identical with, that of a freshly cut horse-radish. A smarting sensation in the eyes was sometimes felt when examining specimens with a hand-lens at the moment when an ejection of secretion took place.

A large drop of secretion could be removed in its entirety from the gland-openings with a fine needle, leaving the integument of the vestibule dry and devoid of liquid. A marked feature of the secreted substance was the extreme rapidity with which it evaporated on a glass slide, leaving a whitish or cream-coloured powdery deposit. This deposit revealed a finely granular appearance under the microscope.

Adaeulum robustum.—The above observations were found to hold good for both *Larifugella natalensis* and *Larifuga capensis* with the exception of the differences in the odour of the secretion already referred to. In the case of *Adaeulum robustum*, of which 20 adult specimens of both sexes were examined, the fine jet of liquid was never observed. The drop of secretion was slow in making its appearance and was much darker in colour, being usually of a reddish-brown tint. *Adaeulum robustum* is an extremely sluggish species, and it was, generally speaking, much more difficult to make it secrete, its response being also slower; the amount of secretion was distinctly less as compared with that of the two previous species. The smell of the secretion resembled that of *Larifugella natalensis*, though much less distinctive.

Cryptobunus silvicolus.—Five adult specimens from Pietermaritzburg were examined. No characteristic smell was detected in this species, which is very much smaller than those previously dealt with. The liquid secretion on evaporation left a whitish powdery residue.

Family *Phalangodidae.*

Metabiantes leighi.—About 20 adult specimens from Pietermaritzburg were examined. A colourless liquid was secreted, the smell not being like that of any particular substance familiar to the observer; it was merely noted as being an unpleasant odour. The liquid was secreted in far larger quantities than in the case of the four previously named species, taking the small size of the animal into consideration. The liquid oozed from the gland-openings and ran along the lateral grooves of the carapace, collecting towards the posterior end of the body, which was often entirely covered with it. On evaporation the liquid left no powdery deposit.

Palpatores.

Only one species of this suborder was examined, namely, 10 adult specimens of *Rhampsinitus levis* at Cape Town. This species does not

secrete readily, and in some specimens no response was obtained. The liquid oozed slowly out of the gland-openings; it was clear, light violet in colour, and did not possess a distinctive odour. No fine jets of liquid were observed in this species.

Summary.

The activity of the odoriferous glands in general seems to be considerably more marked in the case of Laniatores than in Palpatores. This is also the opinion of Kästner (1935, p. 352). Within the suborder Laniatores it is again more marked in members of the family Triaenonychidae. The observations of the secretory processes of South African Laniatores (*Larifugella natalensis* and *Larifuga capensis*) agree very well with the accounts of other authors, especially that of Sörensen (1879), who also examined specimens of Laniatores and noted the yellow colour of the secretion. His explanation of the colour being due to drops of oil suspended in it is, however, doubtful in the case of South African species, in view of the extreme volatility of the secretion in the latter. It seems more likely that the yellow colour is due to a powdery substance, which, as has been described, is deposited on evaporation. The chemical composition of the secretion is unknown.

Some species of South African Laniatores seem able to expel the secretion of the odoriferous glands either rapidly in the form of a fine jet, or more slowly as a large drop adhering to the opening of the gland. The odour is very strong and characteristic in Laniatores, but not nearly so noticeable in Palpatores. The ejection of the odoriferous substance is almost certainly a defence reflex, though its use by harvest-spiders against other organisms has not yet been observed under natural conditions.

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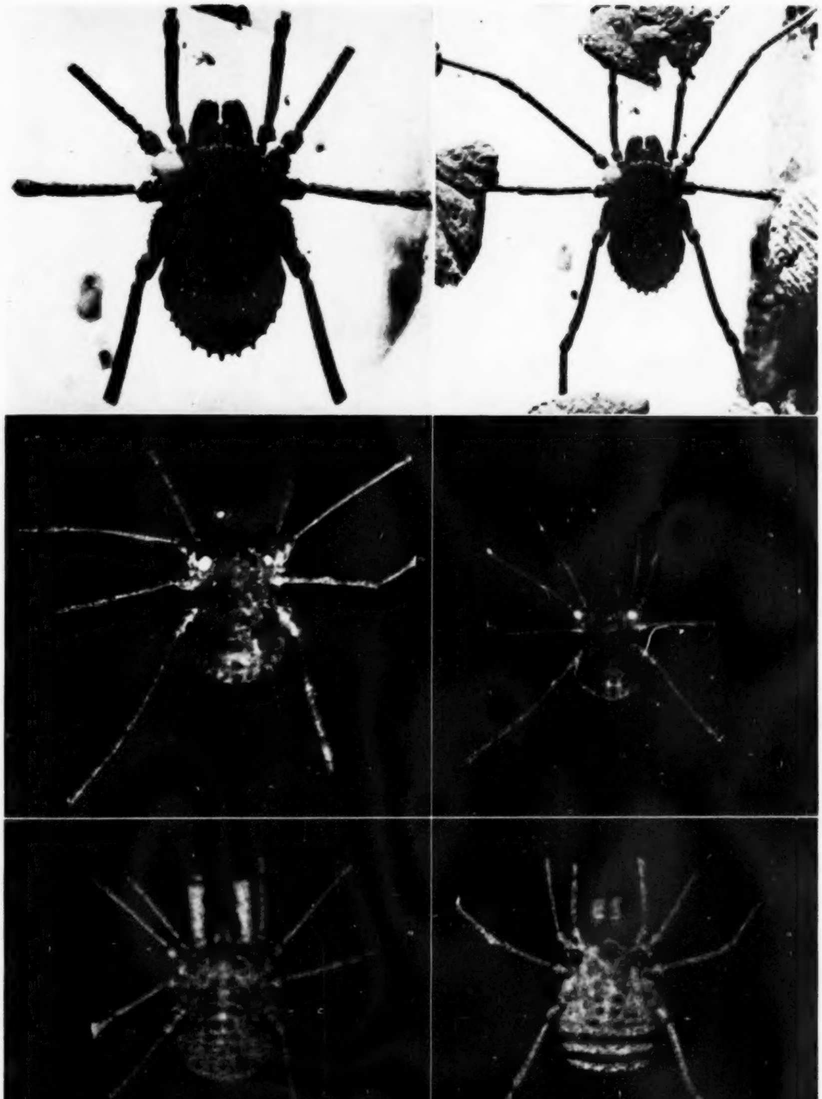

1. 2. 3. 4. 5. 6.

Living harvest-spiders, showing drops of secretion at the openings of the odoriferous glands. 1. *Larifugella natalensis*, ♀ (×5), with a drop of secretion adhering to one side of the carapace. 2. The same specimen (×3) with legs fixed to a glass plate for photographing. 3. *Larifugella natalensis*, ♂ (×3·7). 4. *Larifugella natalensis*, ♀ (×2·3). 5. *Adaeulum robustum*, ♂ (×3·5). 6. *Adaeulum robustum*, ♀ (×3·5), showing the darker colour of the secretion in this species.

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THE CLIMATE AND STONE IMPLEMENTS OF ROOIKOP.

By J. C. SMUTS (Jun.).

(Communicated by C. VAN RIET LOWE.)

(With seven Diagrams and five Text-figures.)

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Slightly to the north of Pretoria lies that vast basin-shaped geological phenomenon known as the Bushveld Igneous Complex. In plan it is roughly oval, 250 miles by 150, and pointing west to east. Situated centrally in the Complex is a large expanse of perfectly flat bush-studded country, 2500 square miles in extent, known as the Springbok Flats.

In traversing the Flats on foot, one cannot help being struck by the unlimited quantities of prehistoric stone implements which litter the ground surface. The late Dr. P. A. Wagner, who carried out a geological survey of the Flats area, was led to estimate these stone implements at some scores of millions. He was also impressed by what he considered to be a series of beds displaying alternating arid and humid characteristics (1).

Generally speaking, the implements are of similar appearance, being deeply patinated and somewhat worn, and all being fashioned to almost similar size from red Rooiberg felsite. Consequently, there is a tendency to classify them as all belonging to an identical remote age. They have generally been referred to vaguely as being of Mousterian or Middle Stone Age origin (16). Yet such is not the case, for many sequences and as many ages are represented, ranging from Acheulean and early Fauresmith times right down to Stillbay. For the sake of simplicity we shall speak of them as belonging to three general comprehensive groups of (1) Late Mousterian, (2) Fauresmith, and (3) Stellenbosch.

On the ground surface, as just stated, the former two types occur thoroughly mixed together, and it is difficult to classify them with any degree of satisfaction. It was, however, obvious that these two types were not of similar age. Yet superficial difference is not sufficient for systematic classification. Some more tangible and cogent evidence had to be produced.

With this in view a careful search was undertaken to locate geological sections which might throw light on the problem. Such a section was found on the southern boundary of Rooikop (No. 509).

This farm is situated on the Elands River, some 12 miles below the present Rust-der-Winter Dam, not far from the lower edge of the Springbok Flats. The river here flows down a gentle valley, and has in days gone by built for itself a low broad terrace or peneplane not far above the present river level. The terrace near the farm boundary slopes perceptibly down towards the river, and in consequence has in numerous places been eroded into deep storm-water dongas, exposing sections of beds to depths of 6 or 7 feet. Here implements are to be found in great numbers, some still lodged *in situ* in their respective beds.

Briefly the section is as displayed in diagram 1.

H	Black Bushveld turf	9 inches
G	Hard fluviatile sandy gravel	7 ,,
F	Sandy clay of grey colour	8 ,,
E	Sandy fluviatile gravel and c. tufa	6 ,,
D	Coarse gritty pebble gravel and c. tufa	9 ,,
C	Coarse fluviatile sand and calcareous tufa	10 ,,
B	Waterworn pebble bed	7 ,,
A	Bed-rock	

DIAGRAM 1.—Section of Rooikop Beds.

Some of the beds require a more detailed description.

Bed B is a layer of large-sized water-worn pebbles, set in a coarse sandy matrix, and obviously deposited under extremely wet conditions. Pebbles 1 inch to 6 inches.

Bed C is a layer of coarse fluviatile sand plus a strong admixture of calcareous tufa.

Bed D is a layer of coarse gritty fluviatile pebbles plus c. tufa and ferruginous additions. The percentage tufa varies, but is very great in parts. Deposit of a fairly wet period. Pebbles ¼ inch to 1 inch.

Bed E is a layer of fairly coarse fluviatile sand, and appears strongly connected with bed D.

Bed F is a layer of sandy clay, which is gray in colour and weathers very rapidly.

Bed G is a layer of extremely coarse fluviatile sand, strongly consolidated and resistant.

Bed H is the usual black Bushveld turf surface soil, also a fluviatile deposit but only faintly so.

Beds D and E are implementiferous.

The surface soil has been washed away to varying degrees in parts, exposing the implementiferous beds. Collections were made from the two implement-bearing horizons.

In bed E as well as bed D they appear diffused sparsely throughout its entire thickness.

Bed D yields Levallois III to Levallois V.

Bed E yields Solutreo-Mousterian and Stillbay types.

The tools are all in a remarkably fresh unworn condition, eliminating all possibility of regrading or shuffling by water action after deposition. They must clearly be assigned to the beds in which they occur.

This site at Rooikop may possibly be exceptional for the Elands River terrace, so let us turn to other sites for corroborative evidence. Two further sections are available, one on the adjoining farm Leeuwkraal (No. 312) in the Elands River terrace, the other on an adjoining farm at Mocke Spruit, a usually dry tributary flowing into the Elands just opposite the southern boundary of Rooikop. This series of sites forms roughly the three corners of a right-angled triangle of about 4 miles side.

Consider first the Leeuwkraal sequence, as illustrated in diagram 2.

H	Black Bushveld turf	15 inches
F	Dark grey clay and fluviatile sand	15 ,,
E	Medium-sized fluviatile sand and c. tufa	4 ,,
D	Gritty pebble and c. tufa and ferricrite	12 ,,
B	Pebble bed and fluviatile sand and c. tufa	14 ,,
A	Bed-rock	

DIAGRAM 2.—Leeuwkraal Section.

The difference between this and the Rooikop section is the omission of bed C, causing the ferricrite bed D to rest directly on the pebble bed B. Either C was not deposited or, more probably, it had suffered erosion subsequent to deposition.

The sections are well displayed here at two proximate points, one in the steep river bank, the other in an irrigation ditch. Collections were again made from the implementiferous beds. Unfortunately no tools (only a few haphazard flakes) have so far been located in the pebble bed B, and in this respect the Rooikop site as well as this Leeuwkraal one is disappointing. A careful search may possibly disclose examples in the future.

Turning now to Mocke Spruit, we find that this river is normally dry, only serving to drain off storm-water from the neighbouring hills forming the rim to the Complex. As on the Elands, there is only a solitary terrace, deeply eroded by the river bed. On appearances it would seem once more that these two terraces are identical. Now turn to diagram 3, showing the stratification, and giving the sequence of beds some 3 miles distant from the Elands up Mocke Spruit.

H	Black Bushveld turf	12 inches
	Dark grey clay and little sand and c. tufa	15 ,,
D	Fluviatile sand and grit and c. tufa	16 ,,
C	Hard grey sandy clay and c. tufa	4 feet
B	Upper half of pebble bed and c. tufa	2 ,,
	Lower half of pebble bed	2 ,,
A	Bed-rock	

DIAGRAM 3.—Mocke Spruit Section.

The pebble bed B here is of major interest to the investigator. It is of 4 feet thickness and displays a faint parting at centre. The parting is rendered discernible by the state of consolidation of the two constituent layers, the upper being less resistant to weathering than the lower. In consequence the upper half is disintegrated to a loose rubble, while the lower is still quite intact. The greater resistance of the upper half is probably explained by the presence of the c. tufa.

This parting is not visible in the Leeuwkraal or Rooikop sections. It may be that the beds there are too thin to render the parting evident, or it may be that this variation is purely local.

This section is easily correlated with the Rooikop one. The Rooikop ferricrite bed D contains Levallois-Mousterian types of tools. The Mocke Spruit ferricrite D contains similar tools. In stratigraphical respects the sections are also similar, so that we may assume complete correlation for the two sections.

Bed B assumes added interest here on account of its implementiferous content. A large collection of Upper Stellenbosch type tools was made from the upper half of it. The lower half has so far proved barren, but it does not follow that it really is barren.

Climatic Interpretation of the Beds.

Leaving aside for the moment the implements, let us now try to interpret the various sections geologically.

Because of the wide distribution of calcareous tufa on the Springbok Flats, it was at first thought that it would simplify matters if its exact position on the geological map could be determined. Investigation with this in view was carried out, but only a superficial study sufficed to show that the tufa is of varying ages and occurring in different horizons of beds. In this respect the tufa is disappointing. Yet in another respect it has, throughout the subsequent interpretation of the beds, served a most useful purpose. For, consider for a moment the formation of calcareous tufa in a bed. It is not a bed which is formed independently and separately in the normal way by deposition due to water or wind agencies, but one which forms gradually within some other bed. Its formation is dependent primarily upon increasingly erratic climatic conditions, when lime-bearing ground waters of occasional rain showers are drawn up to the surface, and the lime deposited at the surface due to the evaporation of the water from it. This process is gradual and cumulative, and tends to take place just below the surface, when the first appreciable tendency towards desiccation is experienced. In brief, tufa forms inside existing beds which are in process of drying up (but not dry). If now we have a bed which is obviously a water deposit, strongly impregnated with tufa, we infer two things: Firstly, there was a wet period, resulting in the deposition of the fluviatile deposit. Secondly, there must subsequently have been a decline in the humidity, and a mildly dry period must have set in, during which the tufa was built up in the upper layers of this fluviatile deposit.

Reverting now to our sections on the Elands. We see here a succession of tufaceous fluviatile beds, from which we may infer that there had apparently been a series of former humid and subsequent arid periods.

Because of their association with Acheulean and later stone implements, the beds are recognised as being of Pleistocene origin.

In adopting a climatic hypothesis, it may be asked of what use it is to be to us in our investigations. In Europe there was a series of glacial advances and retreats during the Pleistocene. Such dynamic climatic disturbances in northern climes may well be understood to have had important counterparts much farther afield. This statement is justified when we consider that in order to build itself up and grow, a glacier requires considerable quantities of water. This water it derives from the atmosphere. Various theories (5) explain the source of the moisture in the atmosphere. All agree that at different times, due to numerous causes, temperatures on the earth's crust were made to rise, with consequent increase of evaporation of aqueous matter. Such evaporation would be especially heavy in equatorial and proximate southern hemisphere regions. When we consider that Europe is much farther removed from the equator than South Africa, is it not likely that the humid effects down here were more severely felt? With an increase in humidity an increase in rainfall may be assumed.

Even this assumption of correlated pluvials in Africa and glacials in Europe does not extricate us from all our difficulties. There is still some confusion in the classification of glacial beds in Europe as well as in Africa. Some European prehistorians connect the Chellean and Acheulean with the Riss-Wurm, whilst a more recent school favours the Gunz-Mindel ages. In South Africa little investigation has been done, and the position is still very obscure, but in East Africa more detailed work has been carried out, and more certain results have been achieved. At the moment of writing, researches are being carried out in North Africa on the Nile, and also on the Vaal River at the southern end of the Transvaal, so that most of our major climatic problems should soon be solved.

Let us turn to East Africa during the Pleistocene. Diagram 4 illustrates the climatic changes as interpreted by L. S. B. Leakey (13).

Perhaps there is the possibility of correlating the East African and Rooikop Pluvial phases.

The Kamasian Pluvial was, according to Leakey, one of the greatest of these climatic disturbances of East Africa, both as regards intensity and duration. The pebble bed B at Rooikop marks the major pluvial in the Elands River terrace. This is one climatic reason for the correlation of the pebble bed with the Kamasian. On archaeological grounds, again, we have a stronger reason for this equation. In East Africa Chellean and Acheulean cultures are found to have flourished during the Kamasian (4). At Rooikop Acheulean (and to a lesser extent Chellean) are found associated with the pebble bed.

These two reasons afford fair grounds for correlating the pebble bed with the Kamasian.

Bed C, that of sand at Rooikop (and clayey sand at Mocke Spruit), follows directly upon the pebble bed B. In this bed the retardation of the water flow had already become so great as to render it unable to carry the fine sand in suspension. It is still part of the Kamasian, but represents it in its closing phases, just before the arid part of the inter-pluvial commenced. It is during these inhospitable phases that the calcareous tufa

Name.	Period.	Climate.
Nakuran	Second Post-Pluvial	Wet phase.
		Period of aridity and deposition of aeolian sand.
Makalian	First Post-Pluvial	Wet phase.
		Period of intense aridity. Deposition of aeolian sand. Reddening of all exposed land surfaces.
Gamblian	Second Major Pluvial	Wet (Upper). Pause: mild period. Wet (Lower).
		Long period of earth movements. Erosion. Dry.
Kamasian	First Major Pluvial	Long wet period.

DIAGRAM 4.—Climatic changes of the Pleistocene in Kenya.

formed in this bed. The great drought which supervened yielded ultimately to the onset of the Gamblian pluvial, when the grit bed D was deposited. Particles are larger than peas and show that we have to deal with a pluvial second to the Kamasian in humid intensity. In East Africa the Gamblian was the second most vigorous pluvial after mid Pleistocene times, establishing yet a further link in the chain. In East Africa there was a double peak to this pluvial with an intermediate pause. At Rooikop the coarse sandy bed E represents the second peak. Furthermore, early Mousterian cultures were practised in East Africa during the first phase (6) and late Mousterian during the second phase. These conditions, as we shall see, are duplicated at Rooikop.

A period of desiccation followed this Gamblian, known in Europe as the

Achen Oscillation, and during that time the calcareous tufa and ferruginous matter formed in pre-existing beds D and E. Both at Rooikop and East Africa this drought proved most severe.

The upper beds at Rooikop may readily be correlated with the latter (minor) pluvials of East Africa. In diagram 7 this will be seen in tabular form.

At Leeuwkraal an unfossilised water turtle has been found in the base of the bed G. It is in a badly crumbled state, and need not necessarily belong to that position.

This is one view of the picture, and is painted with the brush of Leakey and Solomon. E. J. Wayland, of the Uganda Geological Survey, leads another school. The essential difference between the two theories lies, as Wayland himself puts it, "that Dr. Leakey and his colleagues had drawn the line between Pluvial I and Pluvial II too high up, whereby much that had been included in Pluvial I should have been placed in Pluvial II." The Kamasian belongs not to the first Pluvial but to the second, and the Chelleo-Acheulean culture of Kenya and Uganda belongs not to the close of Mindel times, but to the end of Riss and beginning of Wurm (7).

Wayland divides his beds into two Pluvials with a series of post-Pluvials. The Pluvials are each divided into two parts or phases. The Kamasian of Leakey occurs only at the base of Pluvial II.

Let us see how this new scheme fits in with the Rooikop evidence.

At Rooikop, apparently just as at Oldoway, the first major Pluvial is entirely absent. So far no pebble bed lower than B has been located. In parts it must be remembered bed B does not rest on bed-rock, and there is the possibility that below it Pluvial I is located. Nowhere has erosion been deep enough to expose such a bed, for the deepest it extends is only 3 feet below B.

A second proposition we have to investigate is whether, assuming that pebble bed B belongs to the Kamasian, the slight internal break represents the two phases of the Kamasian. This parting is only faintly evident at one of the three sites and may be due to local influences. Pebble sizes top and bottom are similar. The fact that a few Acheulean type (Proto-Levallois (9)) tools have been found in the upper half does not prove that they do not exist in the lower half as well. Too few specimens have been found to permit a successful deduction. It is strongly suspected that the whole bed is the result of only a single climatic.

Much space has been devoted in this paper to the discussion of climatics. Stress has been laid on this feature, since what we have noticed at Rooikop appears to apply readily to the entire southern half of the continent. In Southern Rhodesia the Rev. Neville Jones finds Chelleo-Acheulean tools associated with coarse gravels indicating a period of intense erosion (8). Prof. C. van Riet Lowe finds the same in the valleys of the Vaal, the Caledon

in the Free State, and the Great Fish River in the Cape (10). Leakey and Wayland find the same in East Africa and Uganda, and Rooikop evidence is also corresponding. The association of the Acheulean with a period of intense erosion throughout the southern half of Africa may thus be accepted as an established fact.

On the Vaal River, and in the western and south-western Free State, van Riet Lowe is further led to suspect that the Fauresmith culture was practised during another period of intense erosion, subsequent to that of the Acheulean. On the Vaal the two periods are separated by 30 feet of

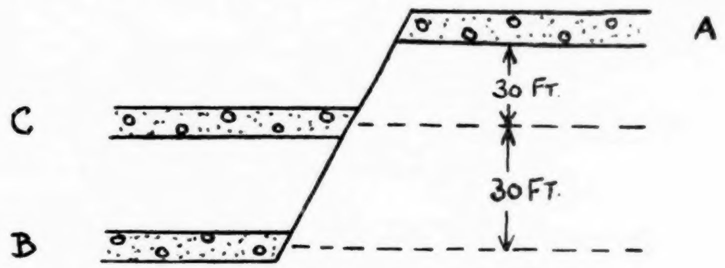

DIAGRAM 5.—Vaal River at Windsorton (reconstructed).

calcareous deposits in parts. Finally, in yet another, but milder period of erosion, we strike the Middle Stone Age Complex (14).

At Rooikop we also have heavy erosion during Fauresmith times, and less heavy during the Middle Stone Age.

Revert again to the Vaal River with van Riet Lowe, where a detailed geological and archaeological survey of the Quaternary beds is at present being conducted by van Riet Lowe and two geologists. The locality is on Riverview Estates, near Windsorton (12). Two "terraces" are displayed, a 60-foot and a "Lower One."

The older terrace is capped by a gravel bed A, and apparently this is the only gravel bed in that terrace. The second terrace contains two gravel beds: B, a gravel, and C an old land surface well above B—a surface represented here by a cut or planed deposit of calcareous tufa, and elsewhere by a gravel bed which, for illustrative purposes, is shown diagrammatically over B in diagram 5. On the surface of bed A we have a pebble culture similar to Wayland's Later Kafuan. Bed B contains Stellenbosch types and worn pebble culture tools apparently derived from bed A; and bed C contains Fauresmith types. There is a great accumulation of calcareous tufa in and below bed C, just as at Rooikop. Tool types in the respective beds at Rooikop and on the Vaal are also similar. It would seem that bed B on the Vaal and the Rooikop pebble bed B are of identical age, and that

bed C on the Vaal corresponds to grit bed D at Rooikop. But how do we account for Vaal gravel bed A? It appears to be a major pluvial of South African Pliocene times. In Uganda Wayland finds pebble cultures connected with his first major pluvial, so that the connection seems here established with East Africa. All these points will no doubt be carefully considered and fully discussed when the geologists complete their survey on the Vaal. Mention of the Vaal is made in this paper only to show that a first major South African Pluvial is absent from the Rooikop beds. That is, Rooikop pebble bed B belongs to a later major South African Pluvial, and not to the first, as the incomplete Rooikop data would lead one to suspect.

Diagram 6 shows a rough diagrammatic representation of the climate oscillations at Rooikop. Magnitude of oscillation is comparative but not proportional.

Leakey in East Africa tentatively suggests (4) that the Nanyukian (East African Fauresmith) be correlated with the first inter-pluvial, and should this be the case in South Africa, then the Fauresmith at Rooikop is post-dated to the East African Nanyukian.

To describe a complicated collection of this type, in which a number of variations occur in each type within a comparatively brief time period, our present South African classification table proved itself somewhat inadequate. For this reason, and also for the sake of greater intelligibility, I have in part had to resort to the European Stone Age schedule. It should always be borne in mind that when a rock is described as Mousterian, it is only indicated that it displays a Mousterian facies, and no attempt is made to correlate it chronologically with the European Mousterian.

Diagram 7 shows the rough classification as derived from the evidence displayed by the collection. An attempt is also made to correlate each group with its specific Rooikop bed. Both these efforts should be regarded as somewhat provisional, pending a more detailed investigation. Rooikop's wealth is not merely confined to the Stone Age, for primitive metal hoes, pottery, and bored stones are also numerous. Pottery especially is most prominent and may be collected in a fine fragmentary form in almost any ploughed field near the river. Some fragments are thin and delicate, others extremely thick and coarse. All are devoid of decoration. There can be no doubt that they are of numerous types and divers ages. Bored stones and pounding- or grinding-stones are occasionally also ploughed up, but it is impossible to draw any inference from these.

The metal hoes are of manganese iron composition and very solid. They are plainly purely of native enterprise.

A pounding-stone and a few scrapers of lower Smithfield type have been collected from bed F.

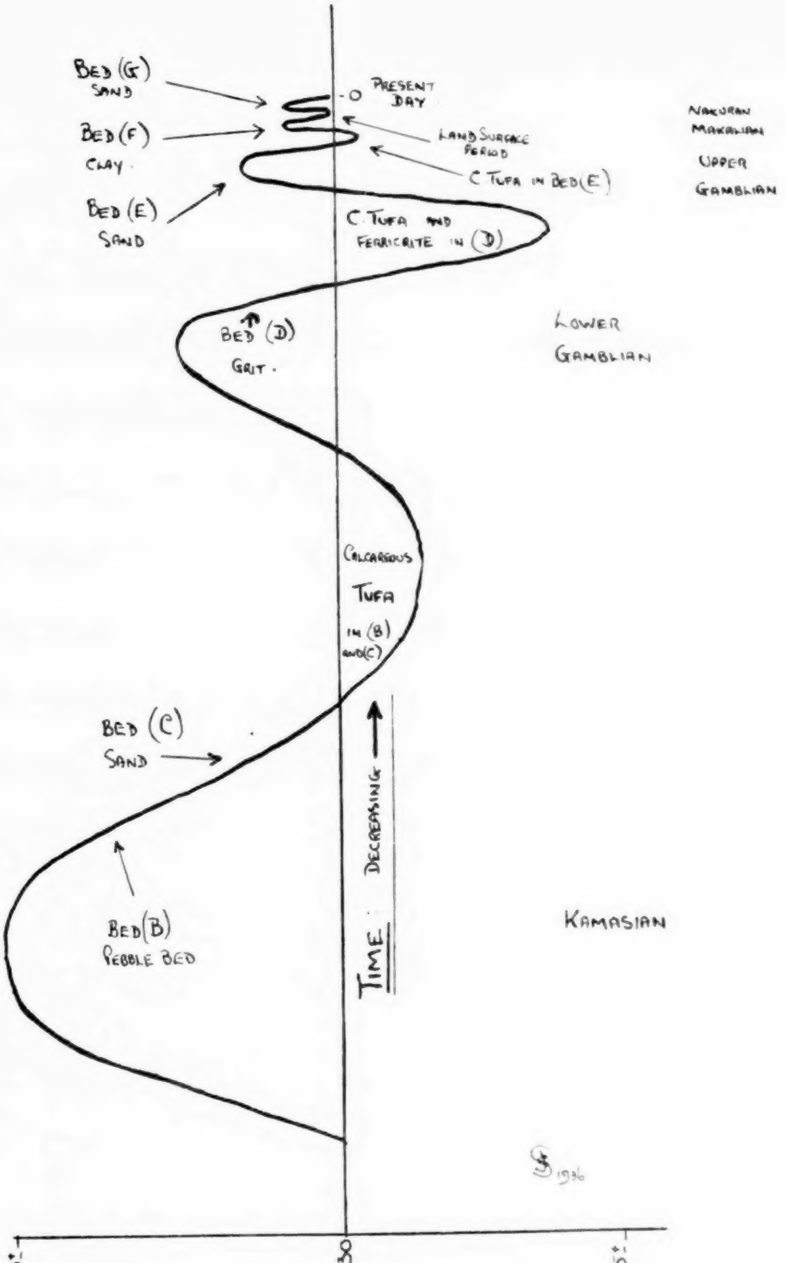

DIAGRAM 6.—Correlation of Beds and Climates, Rooikop.

Rooikop Bed.	Climate.	Rooikop Culture.	East African Equiv.	
			After Leakey.	After Wayland.
H	Present Day	Pottery and Early Metal		
Land surf.	Pause	None		
G	Mild	Pottery	Nakuran	Nakuran
Land surf.	Pause	None		
F	Mild	Smithfield (Aurignacian)	Makalian	Makalian
c. Tufa	Mild to fairly humid	?		
E	Medium erosion	Advanced Stillbay (Adv. pseudo-Solutrean) Springbok Variation (Solutreo-Mousterian)	Upper Gamblian	Pluvial II, Part II (*b*)
c. Tufa	Warm, windy, fairly humid	?		
D	Heavy erosion	Levallois V (Mossel Bay) Levallois III and IV Lower Mousterian (Cordiform) Acheulean VI and VII (Micoque Fauresmith)	Lower Gamblian	Pluvial II, Part II (*a*)
c. Tufa	Long, fairly dry	?		
C and B	Very heavy erosion	Levallois I and II (Fauresmith) Upper Stellenbosch (Proto-Levallois Acheulean IV) Middle Stellenbosch (Upper Chellean)	Kamasian	Pluvial II, Part I

DIAGRAM 7.—Rooikop Beds, Climates, and Cultures.

Throughout the entire range of cultures, red Rooiberg felsite was the predominating, in fact almost exclusive, material used. This is a fine-grained igneous rock of regular dependable cleavage, and occurs in great abundance as pebbles in the Elands River bed. It occurs in two grades of fineness, the red being of extremely uniform imperceptible grain, the grey being slightly coarser, but still exhibiting the fineness of average quartzite. From Fauresmith times onwards, this grey type was superseded by the red.

Let us now describe the implements in more detail.

3. The Upper Stellenbosch or Acheulean Group.

The entire collection was made in Mocke Spruit, from the pebble bed B which had there been laid bare by spate waters. Two coups-de-poing were actually found *in situ* in the upper half of the pebble bed, but the rest of the assemblage was just picked up at random from the jumble of rocks in the river channel. They are in such a fresh unrolled state, that there should be no hesitation in assigning them to this pebble bed. The collection is typically Upper Stellenbosch. The facies are mostly a Mid Acheulean, with a few examples of Upper Chellean (10 per cent.). Coups-de-poing and cleavers feature very prominently, and are practically of Vaal finish. The coups-de-poing are slender and even-edged, and all have almond outlines. Only one with a faint pear-shape tendency was found. Cleavers are of the Pniel type, with rounded parallelogram cross-section. A few Levallois scrapers, primitive blades and knives are met with, and these are fashioned on flakes with unworked bulb or undersides. Although occurring in the same bed, these forms appear remote in technique from the Stellenbosch types. Chronologically they are probably of slightly more recent date. The technique displayed is a pure Lower Levallois (*circa* Stage I and II of Europe). The Middle Stellenbosch is a core technique. Numerous untouched flakes lie littered about.

Coups-de-poing and cleavers occur in various stages of manufacture and it is interesting to note that the technique employed in their construction is identical right up to the final stages. This is Lowe's Proto-Levallois technique.

The process is as follows: A suitable core is first prepared, more attention being paid to the lower or under side. A large flake is then detached sideways, which removes with it this carefully prepared base, and lesser parts of the top.

It depends to a large extent on what shape this flake takes, whether the tool is to be a coup-de-poing or cleaver. Should the flake be obviously chisel-ended, a cleaver is evolved from it by a little further trimming.

Should it prove somewhat almond-shaped, a coup-de-poing will be constructed of it.

The prepared cores do not take the somewhat grotesque shapes that are to be found at Victoria West, and are much smaller. They are shaped not unlike very large unwieldy coups-de-poing.

2. The Fauresmith Group.

Tools of this groupare to be found throughout bed D, which is equivalent to the First Gamblian Pluvial. They all have a somewhat whitish appearance, due no doubt to long association with the calcareous tufa. The assemblage comprises a large range of tools.

Three small coups-de-poing are of Fauresmith pattern carefully worked on both sides, but lacking the finish of the standard Free State lydianite ones. Their exact position is uncertain, but may be assumed as the base of the coarse grit bed D. The facies is a cordiform Mousterian.

Two large cleavers feature as sole representatives of that class, and are incidentally the only really large Levallois tools found. Their design is distinctive, and they are quite unlike the Upper Stellenbosch variety, though they may yet be described as equally distant from my idea of Mousterian technique. There is a touch of the Tachengit about them (see fig. 1, cut 1). In general the collection is mostly of Mid Levallois or a trifle more recent origin.

Points or blades are numerous, and are of fine execution. They are found in all stages of construction, from the primary flake right on to the perfectly complete condition, are long and tapering and comparatively slender. The upper side is worked, but the bulb side remains quite untouched. The flake on which a point is constructed consists basically of an under side constituted by the bulb surface, and an upper side composed of a few longitudinal flake scars converging towards the point. Striking platforms are prepared on the initial tortoise cores, and consist of one, sometimes two or three flakes, but elaborate faceting is seldom displayed. To complete the point a row of secondary flakes is sometimes taken off the two side edges of flake. The bulb side remains quite intact. The finished product is roughly triangular in plan, though somewhat uncontrolled and unsymmetrical.

The technique adopted throughout this group is Levallois, and numerous struck and unstruck cores are to be seen. Butt angles 90 to 100 degrees.

All the usual types of scrapers occur, yet few are tortoise core products. Most are strikingly Mousterian in form. Leakey makes similar comment on the Nanyukian of East Africa (13).

The most common is the side scraper variety. These are divisible into

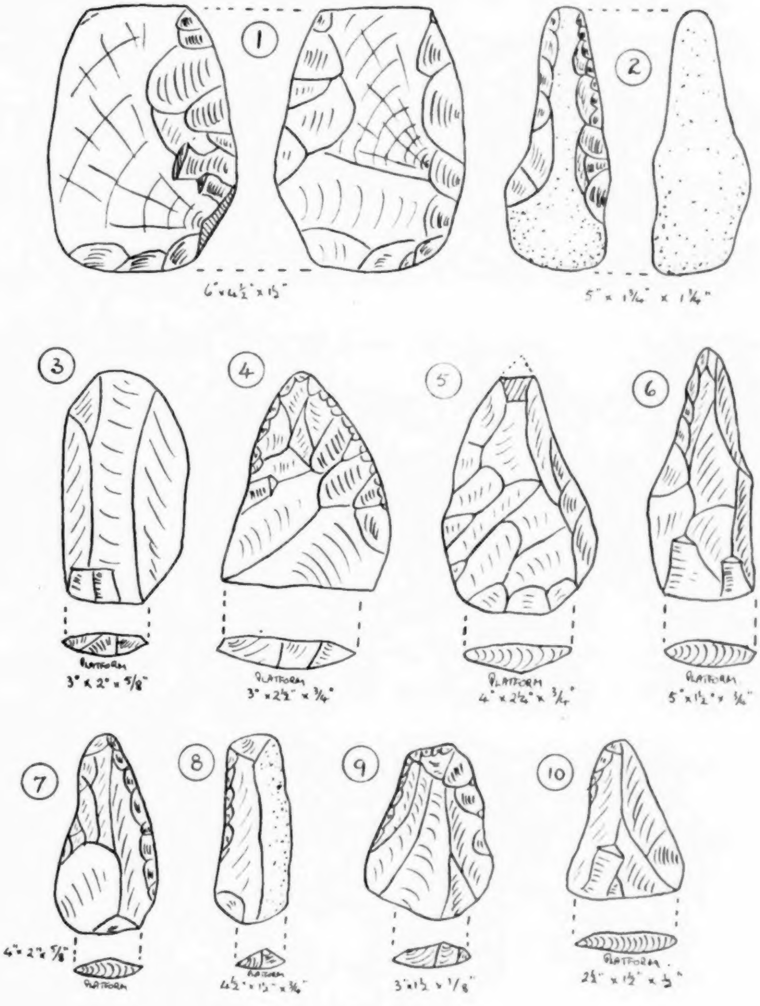

FIG. 1.

1. Lower Gamblian cleaver of Levallois extraction, very reminiscent of the Tachengit.
2. Upper Gamblian borer of Advanced Stillbay type.
3. Kamasian Levallois I type.
4 and 5. Lower Gamblian Levallois III type.
6 and 7. Lower Gamblian IV type with touches of Mousterian.
8 and 9. Lower Gamblian Levallois V types.
10. Lower Gamblian early Levallois IV type.

straight- and crescent-edged types. Both are of large medium proportions, and may be said to be tools for the hand rather than for the fingers. Flakes

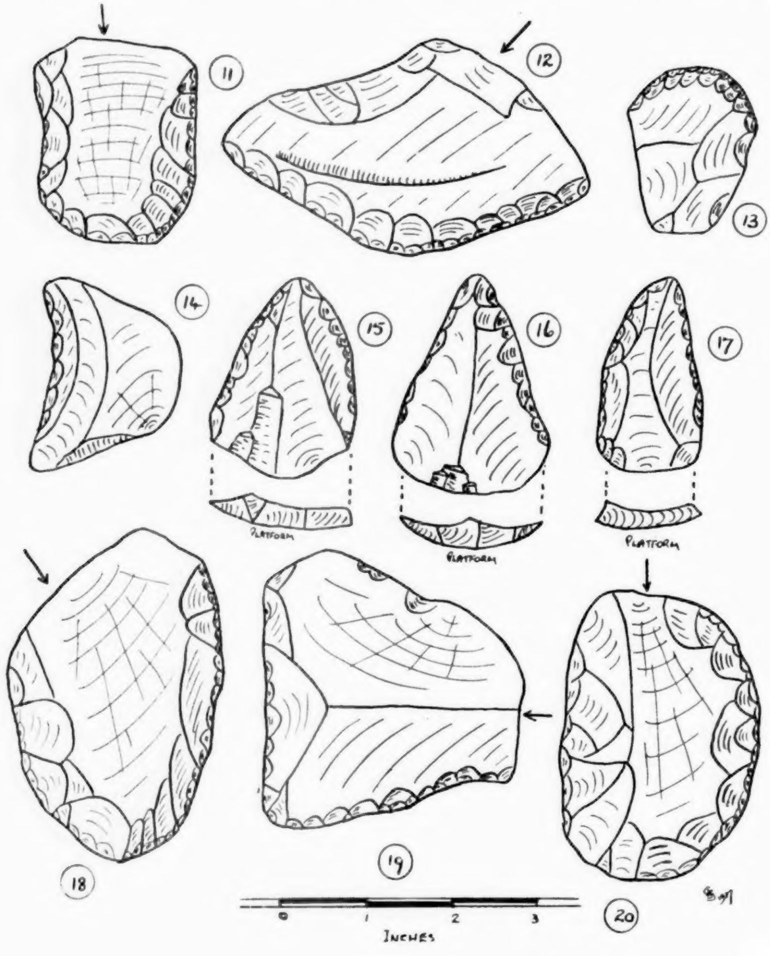

FIG. 2.
11–14 and 18–20. Lower Gamblian Levallois V-Mousterian type scrapers.
15–17. Lower Gamblian Levallois V type blades.

are only worked on the upper side, and the trimming is steep. The edges are of smooth regular contour. Variations of the straight-edged type occur,

the most usual being the triangular scraper with two or three carefully prepared faces.

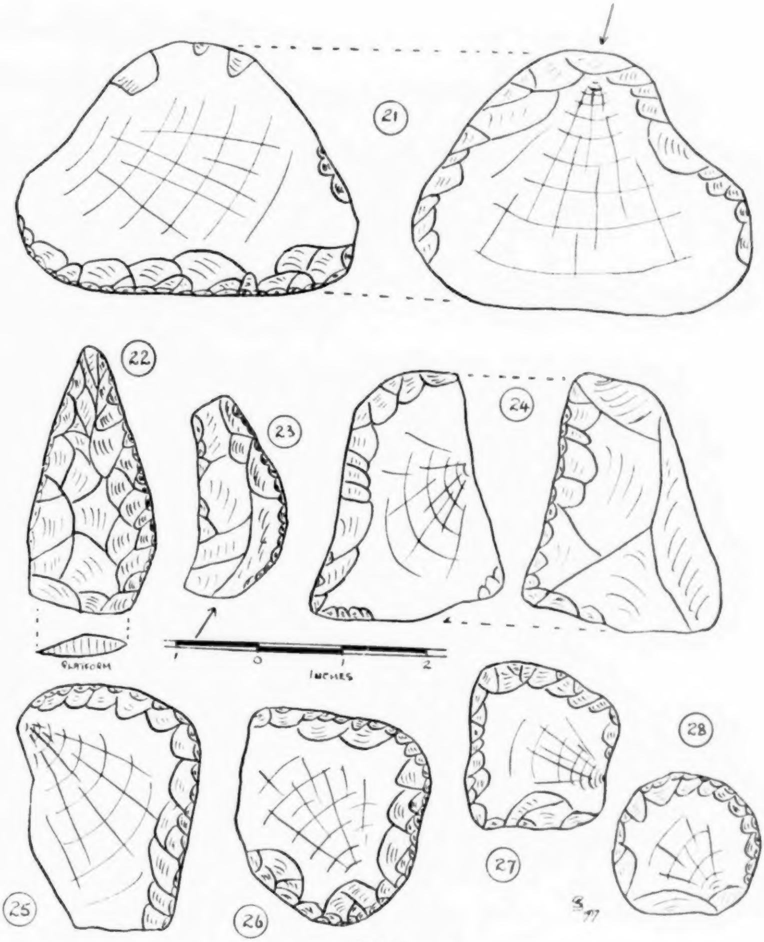

FIG. 3.

21, 23, 25–28. Upper Gamblian Springbok type scrapers.
22. Upper Gamblian Advanced Stillbay type point.
24. Lower Gamblian Levallois V-Mousterian type side scraper.

The notched scraper is a more rare occurrence, and the large diameter of notch indicates application to thick sticks rather than to narrow shafts.

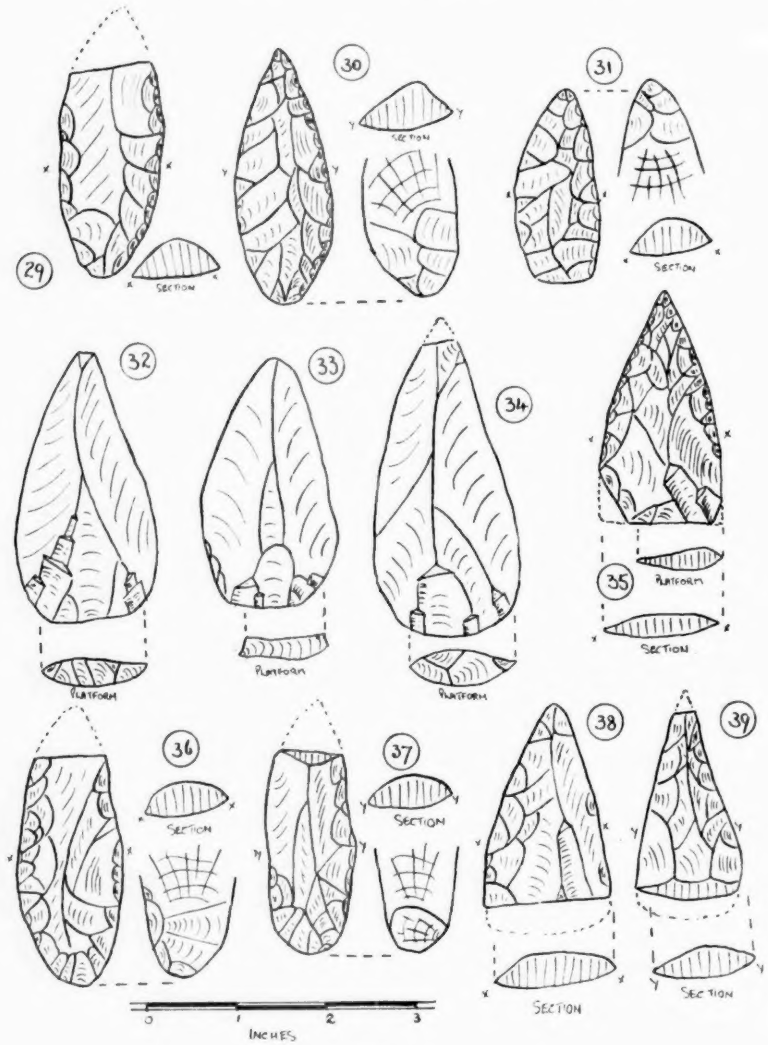

FIG. 4.

29–31, 36–39. Upper Gamblian Springbok type points.
35. Upper Gamblian Advanced Stillbay type point.
32–34. Lower Gamblian Levallois V type blades.

The effort is rough and somewhat unsymmetrical. End scrapers are equally rare.

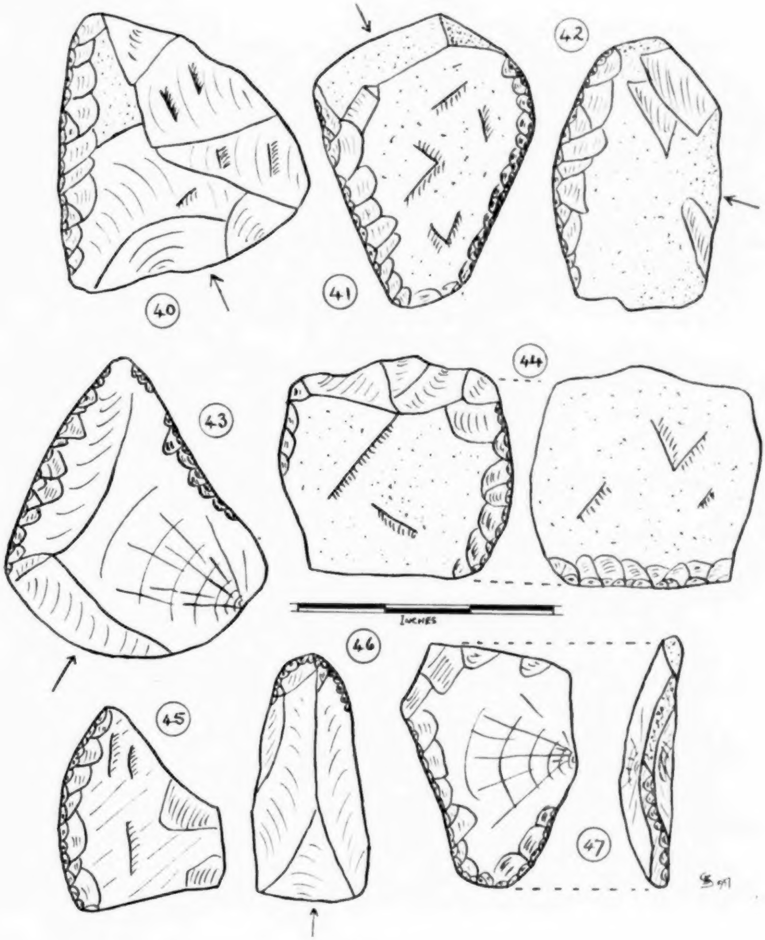

FIG. 5.
40–47. Upper Gamblian Advanced Stillbay type scrapers.

Numerous knives were collected. The more usual is built up in the form of a long slender straight-edged scraper, all chipping and trimming

being limited to one side. The opposite edge is left blunt to accommodate the forefinger.

The most advanced culture of this Lower Gamblian is an Upper Levallois (Stage V). This is the typical Mossel Bay type. The characteristic implement is a flake-point, showing a markedly convergent flaking and faceted butt, and often a central step-flake. It is characterised by its extreme neatness and simplicity, and the fairly marked absence of secondary working. Examples are illustrated in fig. 4, cuts 32, 33, and 34.

1. The Late Middle Stone Age Group.

This group is also well represented at Rooikop. It occurs throughout the sand layer E, which marks the second phase of the Gamblian Pluvial. In general it may be said that in this group, Mousterian, (Aurignacian), and Solutrean influences are fairly inseparably blended. Subdivision into two industries is clearly practicable. The older type has a touch of the Pietersburg about it, the more recent is an Advanced Stillbay. Yet even for its touches of Pietersburg, this older variety can on no grounds be classified as belonging to the Pietersburg variation. In view of the singularity of the older type, it is proposed tentatively to call it the Springbok Variation. A typical point of this group may be described as laurel leaf in plan, and about 3 inches long. In side elevation the shape is a gentle semi-elliptic, and in end elevation (i.e. cross-section) it is almost semi-circular (i.e. very thick). The bulb of percussion which is situated at the rear end of the tool is usually removed by aid of three or four flat flakes. Otherwise this side of the tool is left untouched. The upper side is cross-flaked in the nature of a rough Solutrean technique. Edges are pressure trimmed. The basic flake is not obtained on a Levallois principle. Lowe thinks the Springbok type just a shade older than the Pietersburg. In comparing the Springbok and Advanced Stillbay types, we find that in the latter trimming is very much more delicate and pressure flaking of a very high order, also that the thickness is greatly reduced, giving a very flat cross-section in contrast to the semi-circular of the former. On appearances the Advanced Stillbay type is undoubtedly more recent. Typical Springbok points are to be seen in fig. 4, cuts 29, 30, 31, 36, 37, 38, and 39. Advanced Stillbay points are featured in fig. 3, cut 22, and fig. 4, cut 35 (unfinished).

The side scrapers and other tools of the Springbok type bear a strong resemblance to a true Mousterian technique, with thick steeply flaked edges. In the Advanced Stillbay type thicknesses are reduced by half, and edges, though equally steep, are very carefully pressure retouched.

It is perhaps necessary here to introduce a note on this Advanced Stillbay type. A normal size for a point would be $2\frac{1}{2}$ inches long by $1\frac{1}{4}$ inch

wide at the butt. Work is confined to one side and of minutest character, like a "microscopic" Solutrean technique. This description is best appreciated by turning to fig. 3, cut 22. It is probably the last phase prior to the passing of the Middle Stone Age into the Later. I have an identical point from the sand-dunes at Fish Hoek. Chronologically it is pre-Smithfield.

Both Springbok and Advanced Stillbay types are devoid of crescents, which are a feature in the Stillbay, Swaziland, and Howiesons Poort types.

In the Springbok type the most common tool is the knife, and these even now are still fresh and keen-edged.

The makers of both Springbok and Stillbay types of tools were not as particular about appearances as the Fauresmith connoisseurs, and concentrated more on fashioning useful edges. It was not uncommon for Advanced Stillbay man to select any suitable flat-edged piece of rock and fashion a keen edge on to it in order to construct a knife or scraper. One comes upon many odd bits of stone with carefully fashioned edges, which would make an artist of the former Fauresmith turn in his grave! Both concave and convex varieties of scrapers are common. Some are almost delicate in thinness. A few have gently tapering edges, but usually the flaking is steep and facial thickness marked. They are to be seen in all sizes and forms, and definite types were probably fashioned for specific cases. Thumb and heeled scrapers are somewhat unusual, and equally so end-scrapers.

Two specimens of a strange type of tool have been unearthed. It is best described as pick-like in appearance, and was possibly utilised for some such purpose. Van Riet Lowe describes them as "borers."

At Mocke Spruit we have the principal Mousterian site. For some acres the ground has been stripped of its overburden as far down as the grit bed D. This bed here occurs in a hard resistant highly ferrugenous form, which has practically withstood denudation. For this reason the implements of former overlying beds now lie littered on the surface of this hard bed. They are almost exclusively derived from the sand bed E directly above this bed, and are in a weathered but unworn condition. At one place can still be seen the spot where a workman squatted at his craft, for there is a mass of discards, flakes and cores all littered in a very small circle, just as one would expect in a primitive workshop. This shows how little the geology of this area could have suffered by way of disturbance since that distant time.

Conclusions.

These may best be summarised as follows:—

1. That the Stellenbosch (Chellean and Acheulean), Fauresmith (Micoquin and Levallois forms), and Middle Stone Age (Mousterian-Aurignacian-

Solutrean influences) each flourished during a separate pluvial phase, each respective phase being of lesser intensity and separated by an inter-pluvial.

2. That the Lower Levallois (Stages I and II) initially appeared during the closing phases of the Kamasian, and as such is contemporaneous with an Upper Acheulean (Stage V). From this stage onwards up to the conclusion of the Acheulean (Stage VII), Levallois and Acheulean types must have had a parallel development.

3. That the Acheulean survived the Kamasian and continued into the opening phases of the Gamblian. Acheulean Stages VI and VII occur in Lower Gamblian beds.

4. That the Levallois also survived the Kamasian. In the Gamblian it appears to have attained its greatest popularity, when Middle and Upper Levallois (Stages III to VI) forms were practised.

5. That the Fauresmith (both Micoquin and Levallois types) had its origin in the Kamasian (in the Upper Acheulean and Lower Levallois), even though it only properly developed during the Lower Gamblian phase. The Fauresmith may thus be said to be entirely remote from Mousterian influences, and its origin must be attributed purely to Acheulean and Levallois sources.

6. That since the Lower Levallois is practically contemporaneous with the Proto-Levallois, it would appear that the Proto-Levallois cannot claim ancestry to the Levallois. The fact that in the Proto-Levallois the flake is detached sideways, whilst in the Levallois lengthways, lends further weight to this argument.

7. The Mossel Bay occurring in the Lower Gamblian and the Springbok in the Upper, goes to prove that the Springbok type is post-Mossel Bay. The Mossel Bay type terminates the long line of evolution of the Levallois technique on Rooikop.

ACKNOWLEDGMENTS.

In conclusion I should like to extend my very sincere thanks to Prof. van Riet Lowe for his kind advice and assistance. I should also like to thank the many other kind friends who helped me in the field and who so consistently encouraged my venture.

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PAST CLIMATES AND PRE-STELLENBOSCH STONE IMPLEMENTS OF RIETVLEI (PRETORIA) AND BENONI.

By J. C. Smuts (Jun.).

(Communicated by C. van Riet Lowe.)

(With five Diagrams and four Text-figures.)

(Read March 17, 1937. Revised MS. received June 12, 1937.)

During 1934 the writer discovered a series of implementiferous beds at Rooikop on the southern rim of the Springbok Flats. In a paper dealing with this site he advanced the suggestion that the beds were the result of a number of pluvial oscillations (6), and attempted a correlation with the pluvials of Kenya (5) and Uganda (4).

In this paper it is wished to discuss a series of implementiferous beds at Rietvlei and Benoni, and once more to consider them on a pluvial hypothesis. In this sense the present paper is a sequel to the Rooikop one; yet on an age basis the matter herein far predates anything found at Rooikop.

The purpose of this paper is to introduce two further ancient pluvials as well as a number of new implement forms found in association with them. The relation of these pluvials to the Rooikop ones will be given as well as the exact relation of the implements to the Stellenbosch and later cultures. It will be well to remember, however, that we are dealing with events from beyond the deepest fringes of the Pleistocene, so that artifact forms must be understood to be really crude.

The Rietvlei and Benoni sites are separated by about 23 miles as the crow flies. Benoni lies on the high plateau of the Witwatersrand at an elevation of 5600 feet, and Rietvlei at 4900 feet. The little river which flows through Rietvlei has its source near Benoni.

Let us consider each of the sites in turn.

The Rietvlei Site.

The Rietvlei dam, which supplies Pretoria with water, is situated some nine miles south-east of the city. During the floods of May 1936 the overflow storm-waters tore two deep dongas at the lower edge of the spillway

into the earth terrace of the river. These expose sections down to bed-rock for a distance of a hundred yards and completely intersect the solitary terrace of the stream. The bed-rock base is rough and irregular, consisting of diagonally dipping shales of the Pretoria series. Near the hill-side it shelves up in two abrupt ledges. Between the river and the hill-side vertical step-faulting up to 5 feet has taken place in the lower beds, the faulting running across the cleavage plains of the shale.*

Diagram 1 shows a rough plan and cross-sectional elevation of the area concerned.

The beds are as follows and dip at 9°:—

PC: A very hard bed of round water-worn pebbles lying directly on bed-rock and markedly ferruginised. It is up to 4 feet in thickness, with pebble diameters up to 2 inches.

SC: A very hard coarse consolidated sand of fluviatile origin. It is up to 2 feet in thickness and high ferruginised. Must at one time have formed an old land surface.

F: A fine fluviatile sand ferricrite. It is not very hard and weathers to a porous anthill. Thickness 1 foot.

P: A bed of subangular pebbles loosely knit together. At the river it is thin, but towards the hill-side it expands to 12 feet (under talus influence).

SS: Sub-soil of 1 foot thickness resting unconformably on P.

S: A foot of surface soil.

A glance at the beds shows us that we are dealing with a succession of subaqueous deposits. Why, however, have some of the beds ferruginous matter and why others not? Why the large pebbles in some and why the fine sands in others?

Let us consider broadly the general conditions of deposition and ferrugination (2):

(*a*) A high rainfall would enable our Transvaal rivers to assume a phase of active erosion and aggradation.

(*b*) Rainfall 30 to 40 inches, no active deposition. Too wet for the formation of ferricrite. Just a neutral land surface, with slight erosion.

(*c*) Rainfall 25 to 30 inches, ideal for the formation of ferricrite (11).† Land surface period.

* The Pretoria Shales overlie the Dolomites by no very great distance at this point, so that there is just the possibility that the faulting is due to subsidence in the dolomite. The writer definitely favours a simple subsidence hypothesis and does not think that crustal warping played any extensive part.

† That is, for average conditions. Bad underground drainage and profusion of vegetable matter tend to promote the growth of ferricrite at very much higher rainfall figures.

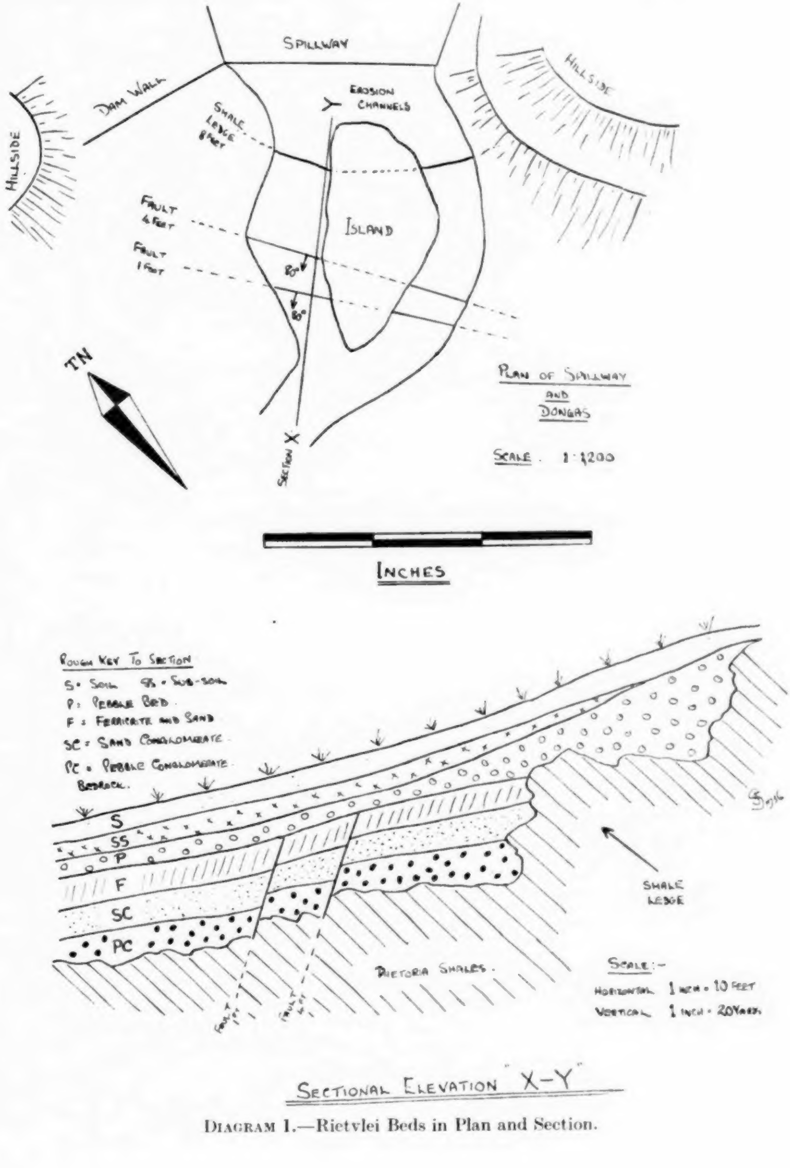


DIAGRAM I.—Rietvlei Beds in Plan and Section.

(*d*) Rainfall 15 to 25 inches, ideal for the formation of calcareous tufa (1),* especially at the higher level.

(*e*) Below 10 inches annual rainfall would induce sandy desert conditions. Too dry for ferricretion or calcretion. Might get wind erosion.

There are no direct means of calculating the duration of a pluvial period, but we may generally say that the larger the pebble the swifter the flow of the water and (probably) the wetter the period.†

These facts will be utilised in the compilation of the curve in diagram 4. For the present it is sufficient for us to realise that the Rietvlei beds display a series of climatic oscillations.

Quartzite artifacts were collected from the sides of the donga walls.

In diagram 2 will be found a summary of beds, climates, and cultures.‡

Bed.	Climate.	Culture.	
Post P .	Comparatively mild	?	
P . .	Very wet	Acheulean I and V.	Top.
		Levallois I.	
		Chellean (Mid).	
		Advanced Pebble.	Bottom.
F, etc. .	Mild to moist	Advanced Pebble.	
		Advanced Alpha and Advanced Beta Flakes (including Proto-Clacton).	
	Long dry period	No implements.	
SC, etc. .	Moist to mild	No implements.	
PC . .	Very wet	Advanced Alpha Flake.	Top.
		Advanced Beta Flake.	
		Advanced Pebble.	
		Upper Pebble, and Beta Flake.	
		Upper Pebble, and Alpha Flake.	Middle.
		Upper Pebble. and Alpha Flake, and Alpha Concavo-convex.	Bottom.

DIAGRAM 2.—Beds, Climates and Cultures, Rietvlei.

* Here again modifications are necessary if much lime is normally present in the soil, whilst underground drainage again plays an important part.

† Size of pebble is dependent, apart from velocity of flow, turbulence and depth of water, also upon the lode of the stream in solid abrasive materials.

‡ At both Rietvlei and Benoni the ferricrite is underlain by pebble beds and dip is

Implements.

The pre-Stellenbosch cultures from bed PC are new, and a description of the various types is necessary. The most striking feature of this bed is the side by side occurrence of flake forms with core forms throughout its entire thickness. It does not follow that they were all constructed by the same primitive beings. Nor does it follow that they were constructed by two types of beings simultaneously inhabiting the valley. For it must be remembered that the formation of bed PC probably took a hundred thousand years, and that during this protracted period a number of alternating habitations might have been staged by each type. This is the view the writer holds. Prof. van Riet Lowe, however, thinks them "integral parts of the same culture."

The Pebble Cultures.

Under this heading we get a wide range of types constructed on smooth roundish and subangular pebbles. The series commences with the crudest imaginable examples, and terminates with types that might almost be described as pre-Chellean in form. The evolution from the very crude type to the more advanced one seems continuous and progressive.

The Pebble Cultures found here and at Benoni the writer subdivides into four types :

(1) The most primitive and oldest is the Primitive Pebble Culture. On appearance it is older than anything Pliocene Europe can produce. It does not correspond to Wayland's Kafuan forms of Uganda (3). It more closely resembles a proto-Oldowan. In this type the work is almost infinitesimal, and human agency often disputable. Seldom more than three flakes are struck off. Implements usually are of irregular shape and flakes are struck off at random, often all in the same direction. Sometimes an implement consists of a single bite taken out of the side of a pebble. Comparatively few are large and unwieldy.

(2) The Lower Pebble Culture is next in order of age. It corresponds to Leakey's Lower Oldowan of Kenya (19). The European equivalent would be a proto-Icenian or proto-Darmsdenian. Parallels with Europe should not be drawn, however, since flint gives vastly different results to quartzite. Tools vary in size from golf balls to croquet balls. Flaking is always in two directions, and work never extends more than half-way round the pebble. The most typical tool consists of a base constituted

in excess of 7 degrees, so that both surface and underground drainage must be considered good (normal). It is also unlikely that the dry inter-pluvial climate could have promoted a very luxuriant vegetable growth, thus here again ferricretion could not have received any undue or abnormal stimulation.

by a single flat flake surface with three flakes knocked off at right angles to this round the edge.

(3) The Upper Pebble Culture is a still more advanced form. It corresponds to Leakey's Upper Oldowan. Flaking is in either two or three directions, and chipping extends more than half-way round the pebble edge.

(4) The Advanced Pebble Culture is the culminating phase of the Pebble Culture, and is best described as almost pre-Chellean in form. The pebble shape is difficult to recognise at times. The basic hand axe has already commenced.

Primitive Flake Cultures.

There are only two of these :

(1) The Alpha Flake Culture is a type in which platform angles are inclined at 120 degrees to the major axis. Sizes vary from a penny to a dessert-spoon. The striking platforms are always natural, and the bulb under-sides are never tampered with. The tool is simple and elementary in the extreme. A variation of this Alpha type is the Alpha concavo-convex variety, which consists of a flake struck parallel from a flake. The upper surface consists of a longitudinal concave flake scar flanked by a flake on each side of it. There is no secondary trimming.

Culture.	Platform angle.	Number of flakes struck.*	Shape.	Size.
Beta Flake . .	90°	3–6	Triangular	2 in. × 2 in.
Alpha Flake . .	120°	3–6	Square	,,
Alpha Concavo-convex	120°	2–6	,,	,,
Advanced Pebble .	Core	6–12	Pointed	Golf ball to croquet ball.
Upper Pebble . .	,,	6–10	Round	,,
Lower Pebble . .	,,	4–6	,,	,,
Primitive Pebble .	,,	1–4	Subangular	,,

* This excludes the bulb under-side.

Diagram 3.—Summary of Implements from First and Second Highveld Pluvials.

(2) The Beta Flake Culture is one in which platform angles are at right angles. Platforms, as before, are natural. Sizes as in the Alpha type. Bulb sides are never touched. The top surface consists of a few very elementary flake scars. There are no concavo-convex forms. The Beta

type has been seen in diagram 2 to be more recent than the Alpha type. There is sometimes a little secondary trimming.

For a general summary of implements see diagram 3.

THE VARIOUS TYPES OF PEBBLE CULTURE IMPLEMENTS.

The Pebble implements may be roughly described as general purpose tools. Man had only dimly learnt to specialise. A sharp edge was his prime objective.

To get some idea of the various standardised types, consider the range in the Lower Pebble Culture of the Second Pluvial.

1. *Side Scrapers.*—These all consist of some flat form of base with steep chipping round the edge. The basal platform varies:

(*a*) Sometimes it consists of a single bulb surface, specially struck for the purpose (see fig. 1, cut 8).

(*b*) Often this bulb surface has been further trimmed, almost in a secondary fashion (see fig. 1, cut 2).

(*c*) Most usually a flat weakness or cleavage plane in the rock is utilised as the base (see fig. 1, cuts 3 and 4).

(*d*) The cleavage plane may be secondarily trimmed as in (*b*) (see fig. 1, cut 1).

(*e*) Often the base merely consists of a flattish portion of the pebble itself (see fig. 1, cut 7).

2. *Short-edged Hide Rippers.*—These are constituted by a tool with an edge like the prow of a boat. The point of the prow does the cutting. It is clearly a proto-rostrocarinate type (see fig. 2, cuts 9 and 10).

3. *Long-edged Hide Slicers.*—These are produced by equal flaking on two sides of the pebble to produce a longish edge. Chipping is at the sharp end of oblong pebbles (see fig. 2, cuts 13 and 14).

4. *Pointed Borers or Awls.*—These are so chipped as to give a sharp tapering point (see fig. 2, cuts 11 and 12).

5. *Choppers.*—Large round pebbles are selected and chipping is as in (3) (see fig. 1, cuts 5 and 6).

In the Primitive Pebble types from the First Pluvial, similar but cruder tools are met with. They are as follows:—

$$\left.\begin{array}{l}1\,a.\ \text{(See fig. 4, cuts 32 and 33)}\\ 1\,c.\ \text{(See fig. 4, cut 30)}\\ 1\,d.\ \text{(See fig. 4, cut 31)}\\ 1\,e.\ \text{(See fig. 4, cuts 36 and 37)}\end{array}\right\}\text{Side Scrapers.}$$

$$\left.\begin{array}{l}4.\ \text{(See fig. 4, cut 34)}\\ 5.\ \text{(See fig. 4, cut 35)}\end{array}\right\}\text{Awls and Choppers.}$$

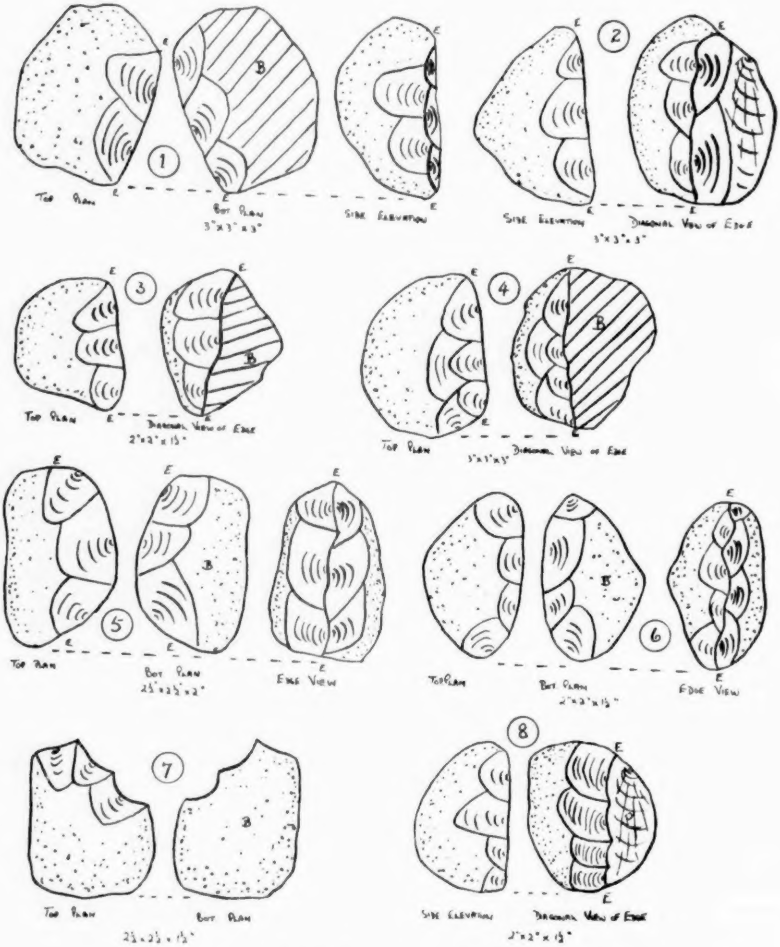


FIG. 1.—Lower Pebble Types from Second Pluvial, Benoni.

1 and 2. Side-scrapers with secondary worked base.
3 and 4. Side-scrapers with plain cleavage base.
5 and 6. Choppers, showing chipping on both sides of edge.
7. Scraper with pebble underside.
8. Side-scraper with simple bulb base.

Tools from the Second Pluvial are obviously derived from those of the First. They are more extensively chipped and better finished and of more

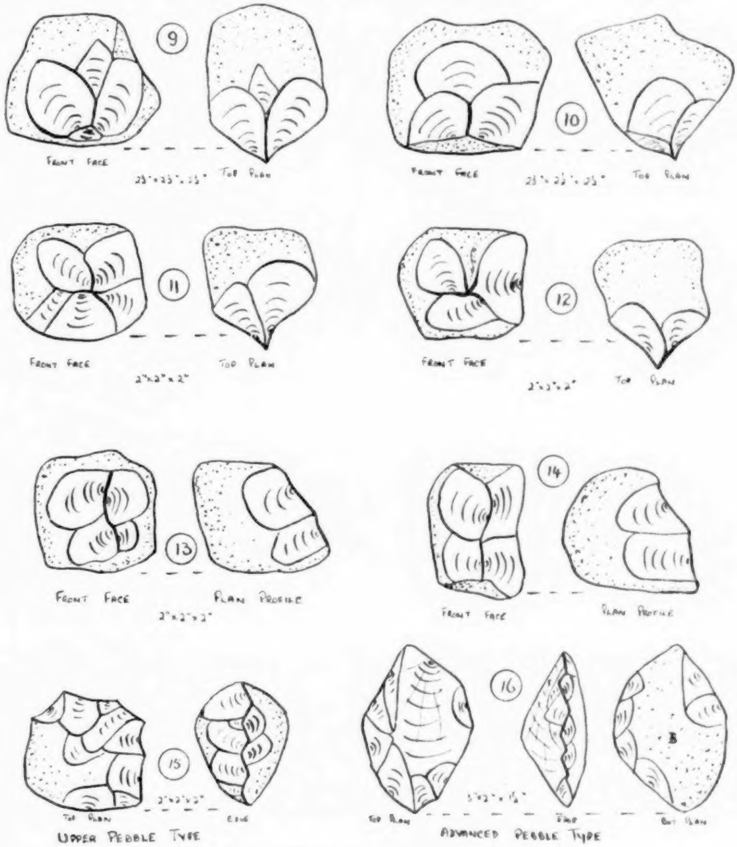


FIG. 2.—Pebble Types from Second Pluvial, Benoni.

9 and 10. Lower Pebble type short-edged hide rippers.
11 and 12. Lower Pebble type pointed borers or awls.
13 and 14. Lower Pebble type long-edged hide slicers.
15. Typical Upper Pebble type side-scraper.
16. Advanced Pebble type side-scraper or chopper.

suitable shape and size. In the Primitive Pebble types from the First Pluvial, pebbles used tend to be subangular more often than round or smooth, and often quite angular.

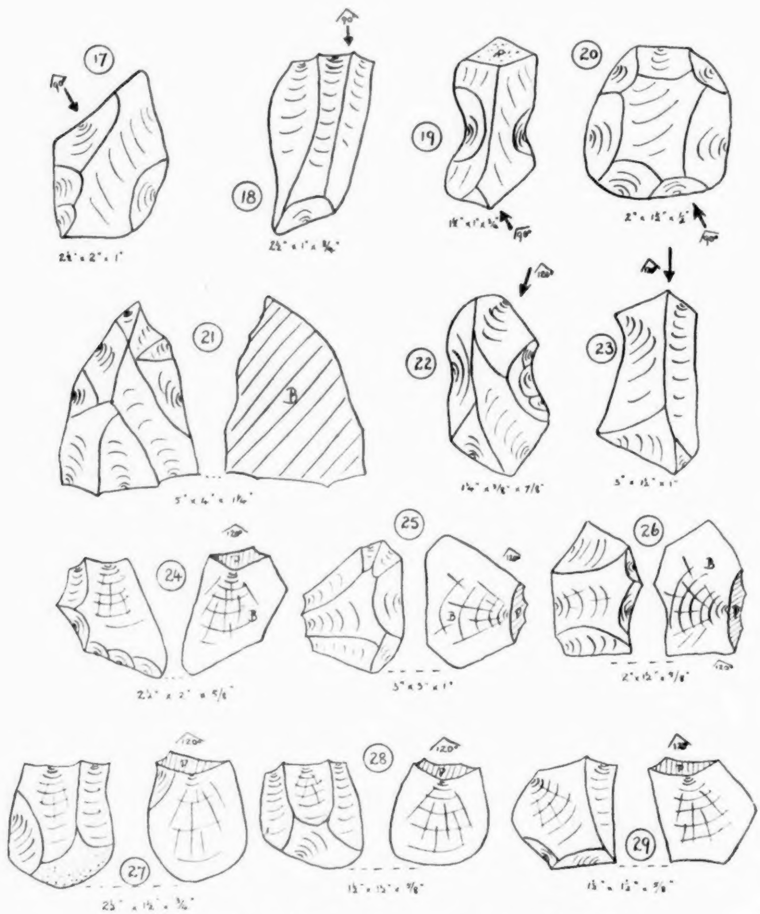


FIG. 3.—Primitive Flake Types from First and Second Pluvials.

17 to 20. Beta side-scrapers, notched scraper, and knife from Second Pluvial.
21. Beta type on natural rock flake. Second Pluvial.
22 and 23. Alpha type knife and notched scraper. Second Pluvial.
24 to 26. Alpha concavo-convex scrapers from Second Pluvial.
27 to 29. Alpha concavo-convex types from First Pluvial.

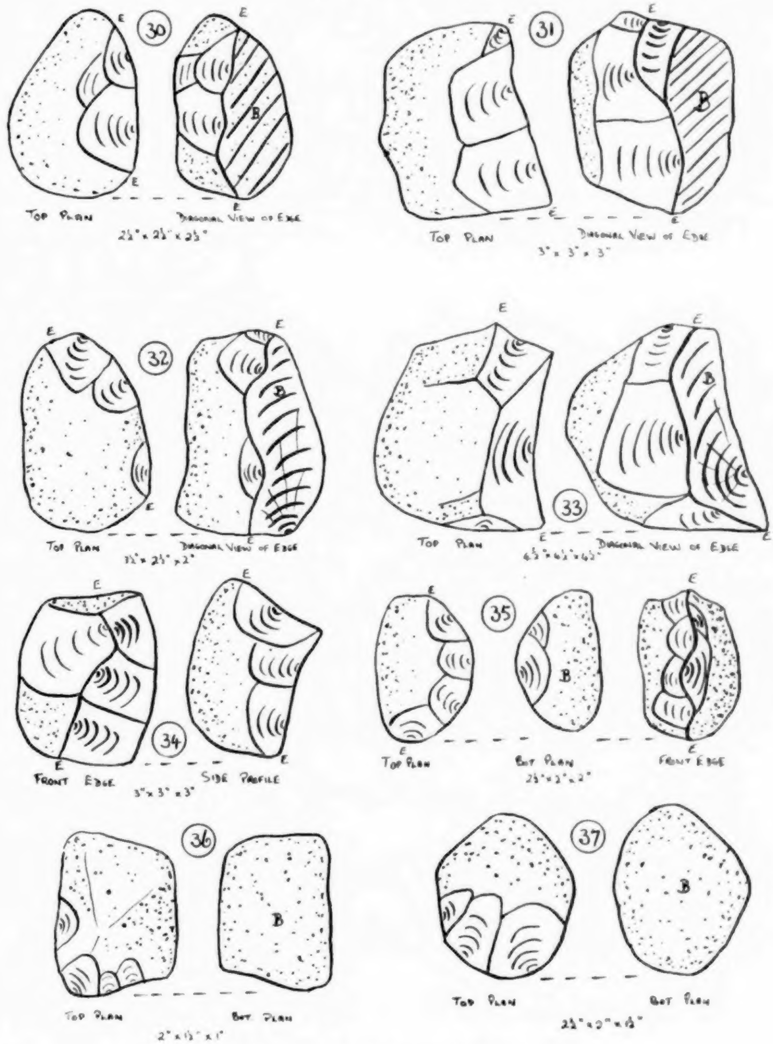


FIG. 4.—Primitive Pebble Types from First Pluvial.

30. Side-scraper on natural cleavage base.
31. Side-scraper on worked cleavage base.
32 and 33. Side-scrapers on prepared bulb bases.
34. Pointed borer or awl.
35. Chopper.
36 and 37. Side-scrapers on flat pebble surface bases.

The Benoni Site.

There is a deep and very conspicuous Karroo pan (10) in the Westdene suburb at Benoni. In summer this pan harbours a sheet of water fully half a mile across, but in the dry winter months it sometimes dries up completely.

On the high fringe of the pan, about 40 feet above the present high-water mark, a series of beds dipping at 10 degrees were exposed by excavations which have proved rich in artifacts. The succession of beds is as follows (see diagram 4):—

E. Surface soil.

D. Sub-soil up to 2 feet. No artifacts. Impregnated with calcareous tufa.

C. Gravel bed of grit and water-worn pebbles up to 2 feet in thickness.* Pebble diameters up to 6 inches. It lies unconformably on the bed below it, and is not as hardly consolidated as Rietvlei bed PC. Throughout its entire thickness it is literally crammed with artifacts. The bed is, unfortunately, too thin to be of much aid in the classification of this jumble of tools.

B. An excessively hard red bed of ferricrite up to 4 feet in thickness and studded at its centre with water-worn pebbles up to 4 inches. The demarcation between this bed and bed C is very marked, rendering confusion quite impossible. The surface of this ferricrite bed was heavily eroded, in parts quite washed away, before bed C was deposited on it. Bed B has yielded three dozen very rough Primitive Pebble Culture types and a similar number of Alpha types (plain and concavo-convex).

Here is a summary of artificats from bed C:

Primitive Pebble type	9 per cent.
Lower Pebble type	23 ,,
Upper Pebble type	31 ,,
Alpha Flake type	10 ,,
Beta Flake type	15 ,,
Unclassifiable flakes	12 ,,

* Below the 40-foot level this pebble bed becomes strongly impregnated with calc. tufa and pebble diameters increase in size, pebbles as well becoming smoother and rounder.

Pluviation.

Let us adopt a pluvial * hypothesis for the deposition of the sub-aqueous beds of Rietvlei and Benoni as recommended in the Rooikop paper.

At Rietvlei we have a series of beds which takes us from pre-Kamasian to Kamasian times (*i.e.* bed PC to P). (I use the term Kamasian in a very broad sense and purely for sake of simplicity.)

At Rooikop, on the southern rim of the Springbok Flats, we have a series of beds which commence in Kamasian times and take us right on to the present.

At Benoni (as will be explained later) we have a series of beds commencing with the oldest of Rietvlei and going back yet one pluvial farther into the past.

There is a common factor in each pair of these three equations, so that by considering all three we may get a continuous chain of climatic conditions for the Central Transvaal. The pluvial curve in diagram 4 gives a summary of these major disturbances more or less to scale, and also a list of associated artifact types.

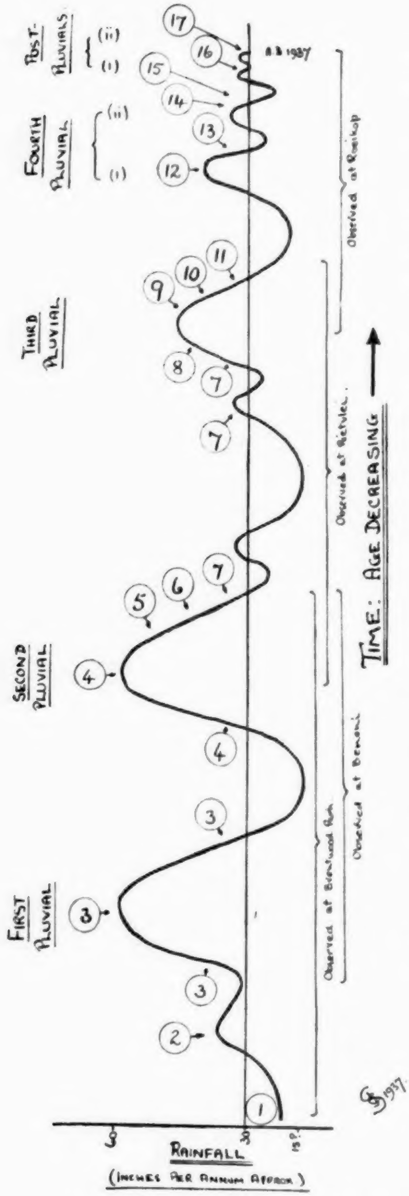
A note on pebble gravels is here necessary. During the first half of a pluvial, its flood waters are progressively accelerated as the pluvial grows in intensity, and it is only after having reached a peak period that the floods slowly subside. During the first period the river actively scours its channel, and all deposits are periodically washed away. During the second period the retarded flood waters become progressively unable to carry heavy burdens, and deposit or aggrade them on the previously eroded channel floor. This is the pebble-bed period. Remember, then, that all river pebble beds only represent the latter half of pluvials.†

The formation of the gravel beds at the Benoni pan is different. The pan is a quiet little spot with no inlet and no outlet and but a small catchment area. The deposition of the gravels ‡ cannot thus be attributed to

* A strictly true definition of Pluvial Periods would be: The long moist periods of Southern Latitudes, corresponding to the Ice Sheets of Northern ones. No definite conditions of moistness can be given as this is a variable dependent on many factors. But we may generally say that during those periods rainfall was very much above the average (or present).

† It has been suggested to the writer that the boulder gravels of Benoni had their origin in the disintegration of the Government Reef conglomerates or in the Karroo Series, but pebble sizes, diversity of materials and variation in angularity of pebbles renders this view quite untenable. Pebbles were formed (the process can be seen continuing to this day) at the shore line by co-abrasion due to wave agitation during windy periods.

‡ This is a perfectly rational hypothesis for normal narrow or fairly narrow river valleys or depressions, as, indeed, most of our South African ones are. In cases of very wide shallow basins, where the river can never be assumed to have flooded the entire



KEY TO INDEX FIGURES.

17. Bantu and Present Day Cultures.
16. Aurignacian (Smithfield).
    Wilton (Tardenoisian).
15. Pseudo-Solutrean (Advanced Stillbay).
14. Moustero-Solutrean (Sprinkbok Variation).
13. Levallois IV to VI (Mossel Bay).
12. Acheulean VI and VII (Micoquian).
    Levallois II and III.
    Cordiform Mousterian.
11. Lower Levallois.
    Upper Acheulean (Proto-Levallois or Clacto-Acheulean).
    (Upper Stellenbosch).
10. Lower Acheulean (Middle Stellenbosch).
9. Chellean (Lower Stellenbosch).
8. Early Chellean.
7. Advanced Pebble (Pre-Chel).
   Upper Pebble (Upper Oldowan).
   Advanced Beta Flake (90).
   Advanced Alpha Flake (120).
6. Upper Pebble.
   Beta Flake (90).
5. Lower Pebble (Lower Oldowan).
   Alpha Flake (120).
4. Lower Pebble.
   Alpha Flake.
3. Primitive Pebble (Proto-Oldowan).
   Alpha Flake.
2. Early Primitive Pebble.
1. Earliest Primitive Pebble (Lower Kafuan).

Period Covered :

Probably more than a million years.

Present annual rainfall: 30 inches.

DIAGRAM 4.—Central Transvaal past climates and stone implements.

flood waters. The gravels formed during the *entire* pluvial period, at which time the pan consistently lapped this 40-foot level. In this respect these pan gravels are of greater interest than river gravels, for they go back half a pluvial phase beyond that possible for riverine depositions of corresponding periods.

Pluvial Correlations.

The various beds described in this paper are, unfortunately, all devoid of fossil remains, so that this method of dating cannot be of aid in the inter-correlation of beds and pluvials. We thus have to resort to the less satisfactory (?) method of assuming similar age for similar types of tools.

Rietvlei bed P contains pre-Chellean, Chellean, Acheulean, and Levallois I types. Rooikop bed P (which is assumed to be of Kamasian age) contains Chellean, Acheulean, and Levallois I types. This establishes the Rietvlei-Rooikop connection.

Rietvlei bed PC contains Upper and Lower Pebble forms as well as Alpha and Beta types. Benoni bed C contains Upper Pebble, Lower Pebble, Alpha and Beta Flake types. Here again we have a connection. The presence of large quantities of Lower Pebble types is accounted for by the greater antiquity of pan gravels when compared to river gravels, for the reason above explained.

Bed B of Benoni is pre-Rietvlei in age.

Classification and Nomenclature of Pluvials.

First Pluvial.—This is represented by bed B of Benoni. During this period the pan waters lapped the 40-foot mark, and the fluviatile part of the bed must have been deposited. But subsequently a dry period supervened and the pan must have dwindled to a small size or completely dried up. It is during the earlier phases of this dry period (before the climate had really grown arid) that the secondary ferruginous and tufaceous matter formed in the bed. During the driest part of the inter-pluvial the bed remained merely a land surface. Later on, at the onset of the next pluvial, the bed was badly pitted and eroded.

*Second Pluvial.**—This is represented by beds C of Benoni and PC of

channel at any time, but where it merely meandered along an ever-changing course, this hypothesis requires some modification. At Rietvlei and parts of Rooikop we deal with narrow basins with rapidly shelving sides.

* It has been asked how the writer distinguishes between isolated storm-water beds and protracted pluvials. Beds of a seasonal storm lack continuity over extensive areas, whereas pluvial beds are most persistent. The former would deposit subangular gravels, the latter boulder beds. The most important evidence is from the implement content: If a series of unrolled tools are found throughout the entire bed, graded in age from the bottom upwards, displaying evolutionary advances which must have taken tens of thousands of years, then the evidence is conclusive that we are dealing with a pluvial bed.

Rietvlei. During its humid phase water must again have stood up to the 40-foot level, later on to subside once more and permit the small impregnation of iron and lime to form. At Rietvlei we have a similar story. PC marks the second half of the humid period and the iron oxide the semi-dry inter-pluvial.

Third Pluvial.—The sub-angular pebble bed P of Rietvlei, or the pebble bed P of Rooikop bears testimony to this wet phase. On the Rietvlei evidence it lacked the humid intensity of the first two pluvials.

Nevertheless, Rooikop points to its being more severe than the pluvial which was to follow.

Fourth Pluvial.—This is a double-peaked pluvial. The first peak is marked by the grit-ferricrite deposit of Rooikop, and the second by the sand-ferricrite. Then follow two post-pluvials which close our climatic history.

Discussion.

Bed B of Benoni has an appearance of incredible antiquity. It is set almost to the hardness of solid rock, and implements are sometimes hacked out in fragments. The quartzite is badly decomposed and artifacts may sometimes be pulverised under the heel.

Rietvlei bed PC also appears extremely ancient, but not as old as B of Benoni. Implements have to be picked out with a prospecting hammer, for they cannot be pulled out by the fingers.

Many of the Pebble Culture tools from the First and Second Pluvials are of excessively crude nature, and many prehistorians will seriously question their artificial origin. This will be specially so with European workers who think in terms of brittle flint, pounding shore lines, tectonic upheavals, or superincumbent pressures. At Benoni we have to consider none of these modifying factors. Implements can be attributed only to some developed tool-making animal. A definite technique and a definite purpose can be detected in almost every tool.

Even the meticulously critical will have to accept the vast majority of the First Pluvial artifacts, especially the concavo-convex Alpha type.

In Kenya Solomon finds three Pleistocene pluvials, separated by long dry inter-pluvials (5). His second pluvial is the Kamasian. Leakey's views concur (18). Wayland, in Uganda, finds two double-peaked pluvials separated by a very long arid period (4).

The Leakey-Solomon schedule appears not unlike the writer's, for implement types suggest a fairly close affinity. The difference, it would seem, is that Leakey-Solomon go back a pluvial beyond the writer. That is, the writer's First Pluvial equals their Pluvial I, Part II.

With Wayland's scheme the points of similarity grow more remote.

On the two last pluvials the writer agrees with him, but on the earlier pluvials implement types do not suggest a strong connection. Furthermore, Wayland considers his Pluvial I ("on general geological grounds") to be of Pleistocene age, whereas the writer thinks there is little doubt that his First Highveld Pluvial is of Pliocene Age. This assumption is based on the following grounds:—

Firstly, on general archaeological features (assuming approximate contemporanity with European cultures) the bed should be late Pliocene.

Secondly, the stage was all set for pluvials in southern climes long before the onset of the Gunz ice-sheet (the equivalent of which the writer takes to represent the commencement of the Pleistocene. The *bos—equus—elephas* system the writer does not consider convincing or satisfactory). Climatic changes in the neighbourhood of the Gunz were very slow and protracted, so that probably long before the manifestation of this ice-cap humidity conditions were favourable to glacier propagation, only the ice-caps had not yet grown sufficiently to enable the period to be called an Ice Age. During this period in southern latitudes humidity and precipitation conditions must already have enabled the onset of a pluvial period. Thus it would seem that pluvials predate glacials.

Du Toit estimates that there was a general uplift of the sub-continent, which in parts exceeded 1400 feet (8). This would be sufficient to induce heavy erosion. Maufe maintains that this uplift would have forced the tropical belt of summer rains farther southwards (9), and thus have enhanced the Transvaal Highveld rainfall. We must expect pluvials in this period.

A duplication of pluviation conditions cannot be expected in Central and South Africa, for Kenya and those parts are under equatorial influence, whereas in southern latitudes totally different climatic conditions prevail. What we do expect, however, is to find evidence of contemporaneous disturbances in both places, even though they may be represented in different magnitudes.

The writer has had the good fortune to discuss his pluvial scheme fairly fully with Professor van Riet Lowe, and found a general similarity between this scheme and Lowe's tentative one for the Vaal River. Lowe is of opinion that the Pleistocene limit should be drawn between the writer's Second and Third Pluvials (and that, he gathers, is going to be the conclusions drawn from the Vaal River Survey). This view is quite acceptable to the writer.

Intensity of Pluviation.—The pan at Benoni is situated virtually on a hilltop with no inlet and an old overflow across the ridge at the 45-foot level. The catchment area is very small and constituted chiefly by the pan's own basin.

At present the annual rainfall of 30 inches is just sufficient to enable

the water to survive the dry winter months. Of the rainfall the pan only receives 10 inches, the other 20 inches being absorbed by the soil.

The present catchment volume is about 109 million cubic feet per annum.

The former annual catchment volume, when the pan stood at the 40-foot level, was about 360 million cubic feet. This was all required to neutralise the annual evaporation head of 7 feet and enable the pan to attain the 40-foot level in summer.

Now it will be seen that the former catchment volume is three and a third times as great as the present. The catchment area we may assume to have remained constant. It follows that the rain-water run off must then have been three and a third times as great, or roughly 33 inches per annum. Add to this a minimum of 20 inches absorbed by the soil and we get a rainfall figure for the first two pluvials of at least 55 inches per annum. Should the pan have overflowed the figure must needs have been greater.

Other Sites of Importance.—The Benoni pan is not the only pan of its kind in the neighbourhood, nor is it the only one to have yielded artifacts. From the ferruginous beds of a pan at the seventeenth hole on the van Ryn Estates Golf Course, three miles east of Benoni, the writer has unearthed an Alpha Flake specimen, establishing the bed as First Pluvial.

At Brentwood Park, six miles north of Benoni, there are two small pans just off the Pretoria road on its eastern side. Excavation for road metal has been done on the northern one, and here very interesting beds, dipping at 6 degrees, are exposed (see diagram 5).

E. Soil.

D. Sub-soil. Erosion bed containing artifacts of the Second Pluvial. Up to 9 inches in thickness.

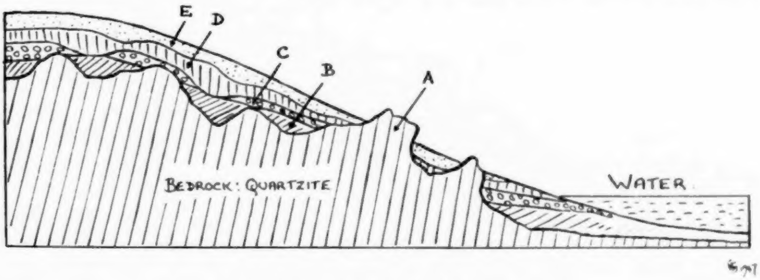
C. Excessively hard bed of gravel, silcrete and ferruginous matter, brown-black in colour and up to 18 inches thick. It has yielded a few Primitive Pebble and Alpha Flake tools, establishing its age as First Pluyial.

B. Fairly hard bed of purple-yellow gritty loam up to 2 feet thick. Searching has only revealed a solitary Primitive Pebble side-scraper. The bed appears to represent a mild to moist period before the onset of the First Pluvial.

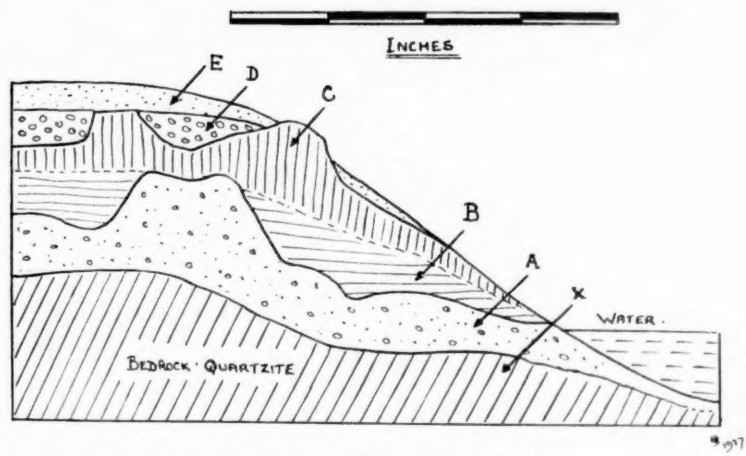
A. A bed of loosely knit red soil plus a little grit and nodulesof ferricrite. Thickness, 3 feet. It is the result of a mild later dry period. From its upper half two pebbles were recovered suggesting signs of artificial flaking. Though evidence of the flaking is very faint, the writer is strongly inclined to uphold their artificial claims. One resembles a Primitive Pebble side-scraper. The other is reminiscent of Wayland's Kafuan split pebble type.

Brentwood Park definitely establishes the fact that implements were being made probably long before the onset of the First Pluvial.

At Wellington, Southern Cape, near the town reservoir, the writer found a few Lower and Upper Pebble as well as Alpha and Beta types in



Rough section of Pan Beds, Benoni.



Rough section of Pan Beds, Brentwood Park.

Diagram 5.

a decomposed granite clay underlying the erosion bed of the Stellenbosch period (Pluvial 3). Stellenbosch hand axes as well as cleavers were found at the same spot in the erosion bed.

Distribution.

Pebble types are on record from Kenya (Leakey, 12), Tanganyika (Wayland, 13), Uganda (Wayland, 14), Belfast, Transvaal (Wayland, 15),

East London (Macfarlane, 16), Vaal River (van Riet Lowe, 17), Pretoria (myself), Benoni (myself), Wellington (myself), Potgietersrust (myself), and Rustenburg (myself).

Pebble types are found in association with Primitive Flake types in Kenya, at Pretoria, Benoni and Wellington.

Summary.

During the Age of Man the Transvaal Highveld must have passed through four pluvial periods separated by inter-pluvials of fairly dry nature. The first two pluvials were of greatest severity, while the last two were each of lesser intensity. There were two minor disturbances within the second inter-pluvial and a slight one followed upon the Third Pluvial. The Fourth Pluvial is double peaked. Following on these pluvial periods, we get, in Holocene times, two small post-pluvials, or humid phases.

Implements are found in all the pluvial stages, but the inter-pluvials are barren, suggesting that man had migrated elsewhere during these inhospitable times.

The Primitive Pebble Culture, which commenced in pre-Pluvial days, flourished during the whole First Pluvial. At the commencement of the Second Pluvial it developed into the Lower Pebble Culture, at the three-quarter stage into the Upper Pebble and during its closing phases into the Advanced Pebble. The Advanced Pebble Culture survived into the Third Pluvial. At the quarter stage it developed into an early Chellean, and at the close of the pluvial it had attained an advanced Acheulean status. The evolution from the Pebble Cultures up to middle Acheulean times appears to have been continuous.

At the late Third Pluvial stage the Proto-Levallois * technique makes its appearance, and this seems to mark the advent of a new hybrid influence.

During the First Pluvial we also had the Alpha Flake type. It outlived the inter-pluvial and continued three-quarters of the way into the Second Pluvial. Here it became extinct. The 90-degree Beta Flake takes over for only a short while, for it is superseded even before the close of the Pluvial by evolved or advanced Alpha and Beta types. Both seem to suggest new influences. These evolved types continued into the beginning of the Third Pluvial. This is probably a simple evolution. Towards the closing phases of the Third Pluvial the Levallois was

* This is after C. van Riet Lowe. The writer prefers the term Clacto-Levallois since the bulb and platform angle usually suggest a Clacton influence.

introduced. Implements of the Fourth Pluvial are merely evolutions of Third Pluvial types.

Thus we have the side by side development of flake and core types right from Pliocene times onwards.

Conclusions.

(*a*) The humanly fashioned artifacts of the First Pluvial lend a far greater antiquity to the habitation of the sub-continent than has formerly been anticipated. They take us back over more than a million years of human endeavour (7).

(*b*) The fault in the lower beds of Rietvlei points to the possibility of the Pliocene earth movements continuing till after the Second Pluvial.

(*c*) Correlation of the writer's pluvials with the Vaal River terraces is very tempting. There can be little doubt that the 60-foot terrace (at Windsorton), in which van Riet Lowe has found pebble tools (of Upper and Advanced type), represents the writer's Second Pluvial. The pebble bed at the foot of the 30-foot terrace definitely represents the writer's Third Pluvial. From this one might argue that his First Pluvial is equivalent to the 200-foot Vaal River terrace—well into the Pliocene.

Acknowledgments.

Dr. L. J. Krige, who is very well acquainted with the Rietvlei site, is in entire agreement with the writer's geological and climatological interpretations of those beds.

Prof. C. van Riet Lowe has kindly looked over the Rietvlei site and examined all the artifacts. He declared himself very favourably impressed by both.

To both these gentlemen the writer is sincerely indebted.

P.S.—Just before this article went into print, Memoir 35 of the Geological Survey, "Geology and Archaeology of the Vaal River Basin," was published. From it, and also as the result of discussion with Prof. van Riet Lowe—who has just returned from an extensive tour of North and Central Africa—it transpires without any vestige of doubt that all that precedes the writer's Third Pluvial must be of Pliocene Age. Thus to prevent subsequent confusion, it is best to rename all the pluvials as from the beginning of the Pleistocene.

The names now adopted are:—

Old Name.	New Name.	Geological Age.
Second Post-Pluvial First Post-Pluvial	Second Post-Pluvial First Post-Pluvial	Recent
Fourth Pluvial Third Pluvial	Second Pluvial First Pluvial	Pleistocene
Second Pluvial First Pluvial Pre-First Pluvial	First Pre-Pluvial Second Pre-Pluvial Pre-Second Pre-Pluvial	Pliocene

The First Pluvial (new nomenclature) corresponds to Vaal River First Wet Phase and probably the Gunz-Mindel of Europe. The pre-Stellenbosch pebble artifacts of the Vaal resemble First Pre-Pluvial Lower to Advanced Pebble types, even though not very typical examples. The variety is very limited and examples appear degenerate.

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AN INTERESTING EARLY POST-LARVAL STAGE OF THE "GALJOEN."

By J. L. B. Smith.

(With Plate X.)

(Read August 18, 1937.)

Family Dichistiidae.

Dichistius capensis C. & V.

1935. Smith, J. L. B., Trans. Roy. Soc. S.A., vol. xxiii, pt. iii, p. 269. pl. xiii.

The common "Galjoen," *D. capensis* C. & V., is one of the best-known angling fishes of the Cape, but little or nothing is known of its breeding habits or developmental stadia. Recently a very young specimen, early post-larval, has been secured, which is of interest in showing that fairly extensive developmental changes occur during growth to the adult stage.

A brief description of the specimen is as follows:—

Depth 2·9, length of head 3·1 in body length. Eye 2·5, and snout 5·5 in length of head. Preorbital very shallow, about 6 in eye. Snout rather blunt, with an angular convexity before the nostrils. Dorsal profile from nape almost horizontal. Preopercle margin strongly serrate, serrae large flat spines round angle. Two small opercular and one sub-opercular spines. Lower jaw projects, mouth very oblique. Teeth incisiform, apically acute (Pl. X, *a*).

D X, 18, 4th spine longest, equal to eye: 8th–10th spines subequal, $\frac{2}{3}$ of 4th. First ray longer than last spine, rays increase to the 3rd, longest, 1·2 in eye, thereafter decrease slowly, making anterior part of soft fin a gently rounded lobe. A III, 14, spines fairly short. 3rd and 4th rays subequal, longest, equal to eye, remainder graduated shorter. Base of anal half base of dorsal, 1·4 in head. Pectoral 1·4, ventral 1·3 in head, latter reaches vent. Caudal almost truncate, very slightly emarginate.

Scales very thin, impossible to count.

Silvery blue, with five dark cross bars becoming darker after death, the first over the nape, wider than interspaces. Anterior 7 dorsal spines in a dark patch. A dark blotch on anterior dorsal rays, and on anterior

anal rays. Distal third of ventrals dark, a dark spot on upper caudal lobe. Pectoral and most of caudal light.

Length.—22 mm. Taken in a rock-pool near the Bushmans River mouth, west of Port Alfred, in September 1936.

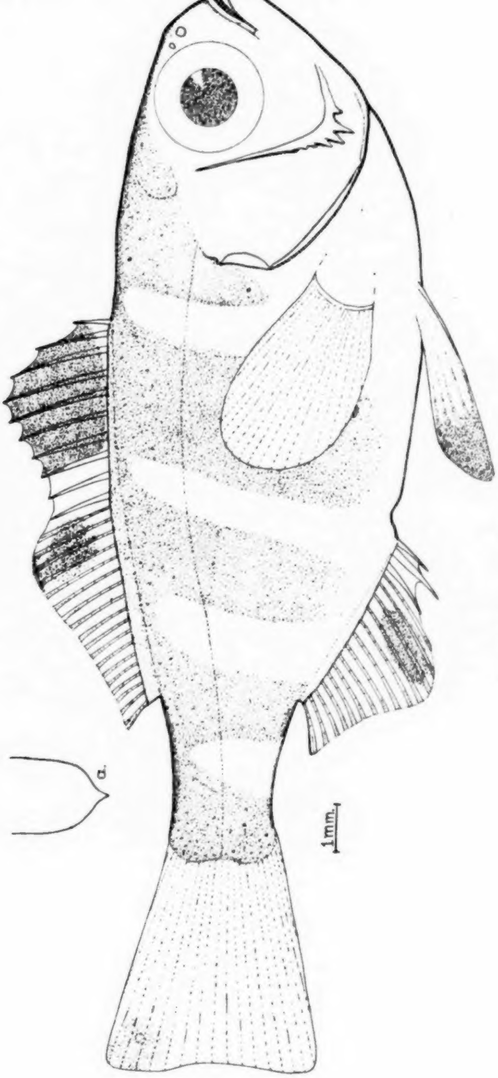
It has previously been observed (Smith, *loc. cit.*, p. 274) that *Dichistius* probably spawns about August. The small specimen now described was therefore likely only a month or six weeks old, representing a very early post-larval stage.

Interesting features are the spines on the preopercle, the shallow body, the truncate caudal, and the anteriorly relatively low soft dorsal and anal. It is noteworthy that the spinous dorsal is of much the same shape and proportions as in the adult. The sharply cuspidate teeth are remarkable: even in mid-juvenile stadia the teeth are more or less truncate, almost chisel-edged.

In general outline the fish resembles a young Stromateid, but the dorsal and anal fin formulae alone leave no doubt of the identity of the specimen.

I wish to express my gratitude to the Research Grant Board of South Africa (Carnegie Fund) for financial assistance.

ALBANY MUSEUM,
GRAHAMSTOWN,
August 1937.



Dichistius capensis C. & V. Juv.
(22 mm. Length.)

J. L. B. Smith. *Neill & Co., Ltd.*

GALLIUM.

Part IV.—The Phosphates and Arsenates of Gallium.

By F. Sebba and W. Pugh.

(With one Text-figure.)

(Read July 21, 1937.)

Of the congeners of aluminium, only thallium is known to form well-defined phosphates; little is known of the phosphates of indium, apart from the statement of Winkler that a white precipitate is formed on neutralising an indium salt solution in the presence of a phosphate, and no work of any kind has appeared on gallium phosphate. Aluminium is the only member of the group whose arsenates have been investigated.

The mineral germanite contains a trace of phosphate and large amounts of arsenic, the latter being converted into the pentavalent form in the course of the extraction of germanium. Both phosphate and arsenate then accompany the aluminium-gallium fraction, and, while the behaviour of the aluminium compounds is well known, there is no knowledge to guide us with respect to the behaviour of the gallium compounds. The study of these, as described in the present paper, has in fact led to the development of a satisfactory method for recovering gallium by alkaline extraction of the mineral (1), and also to the characterisation of crystalline and gelatinous forms of gallium phosphate and gallium arsenate, and of a complex sodium galli-arsenate.

Material Employed.—Gallium metal, obtained from germanite and purified as described by the authors (2), was dissolved in hot concentrated sulphuric acid, diluted, and made up to volume of known strength. The metal used was a part of the sample which was shown to be spectroscopically pure.

Amorphous Gallium Ortho-phosphate.—An aliquot part of the standard gallium solution was diluted to 100 c.c. and heated to boiling; it was then treated with a good excess of ammonium phosphate and neutralised to methyl-red indicator. A gelatinous precipitate appeared while the solution was still distinctly acid. The liquid was kept hot for an hour; it then settled easily and filtered well. The precipitate was washed with 1 per

cent. ammonium nitrate (water gave turbid washings) until free from sulphates, dried, and ignited to constant weight. The weights of ash obtained in four different experiments were: 0·1486, 0·1562, 0·1550, 0·1508 gram; (required for gallium ortho-phosphate, 0·1572 gram).

In order to eliminate the possibility that low results were due to reduction during the ashing of the filter-paper, parallel experiments were carried out using silica Gooch crucibles; the results were similar. However, better results were obtained by reversing the procedure, the gallium solution being added to an excess of hot ammonium phosphate. The precipitate in this case was gelatinous at first but became granular on digesting; when this occurred the solution was neutralised and digested for a further short period. The precipitate was washed with ammonium nitrate as before, and ignited. Found: 0·1566, 0·1572, 0·1556, 0·1564 gram; required, 0·1572 gram.

To establish the composition of the ignited precipitate, several samples were analysed. In the absence of any method prescribed for the separation of gallium from phosphate, the method of Moser and Brukl (3), using cupferron in acid solution, was deemed best suited to give a separation. For the analysis, the ash was dissolved in moderately concentrated sulphuric acid and the gallium was precipitated according to the directions of the above authors; the phosphate in the filtrate was precipitated as magnesium ammonium phosphate, after first destroying the excess of cupferron by boiling with concentrated nitric acid. The following results, typical of many, were obtained: Ga_2O_3; 56·8, 56·2, 55·4; P_2O_5; 43·4, 43·5, 43·2; calc. for $GaPO_4$: Ga_2O_3, 56·9; P_2O_5, 43·1 per cent.

With regard to the inconsistent values for gallium, reference may be made here to the observations, that appear later on this method of analysis. In view of these observations, it is clear that the precipitate is essentially gallium ortho-phosphate. Yet there was evidence that it was contaminated with basic phosphate or with gallium hydroxide. In the first place, it was impossible to wash the precipitate free from phosphate; there was always an opalescence when tested with silver nitrate. In the second place, the ignited ash dissolved easily in acid except for a small trace which required prolonged heating. It would appear that the low yields are due, not to incomplete precipitation, but to progressive hydrolysis of gallium phosphate.

Because of its granular nature and ease of filtration as compared with the hydroxide, with the added advantage of a high conversion factor, gallium phosphate would be a convenient form for the estimation of the element if the correct conditions for quantitative precipitation could be established. For this reason, a large number of experiments were carried out under various conditions. Precipitation in the cold gave a slow-

filtering, gelatinous precipitate that was still low in weight; in the presence of acetic acid the results were lower still. Several precipitations were made with sodium phosphate, followed by washing with water, but the results were similar to those obtained with ammonium phosphate. Finally, the effect of varying the acidity was investigated. The pH value of the filtrate was determined and the precipitate was washed with acetate buffer solutions of the same value, the filtrate and washings being tested for gallium by means of tannin. Small amounts of gallium were found in the filtrates at pH values below 4, and large amounts at pH values above 6·5. Best results were obtained at pH 5 to 5·4 and washing with ammonium nitrate; no gallium was then found in the filtrate. The weight of ash, however, was still about 1 per cent. low. This was due, as already indicated, to progressive hydrolysis and washing out of phosphoric acid. In this respect gallium phosphate resembles aluminium phosphate.

Crystalline Gallium Phosphate.—This was made by a method similar to that employed by de Schulten (5) for aluminium phosphate. 1·05 grams of gallium was dissolved in concentrated nitric acid and the solution was evaporated several times to a syrup, in order to remove nitric acid; the residue was dissolved in caustic soda (10 c.c. of 20 per cent. solution) and then washed into a Carius tube with 5 c.c. of water; 5 c.c. of syrupy phosphoric acid was added and the tube was sealed and maintained for two hours at 200°. The heavy crystalline solid was washed with water containing a few drops of phosphoric acid, then with alcohol to remove the acid, and finally with ether. The yield, air-dried, was 2·08 grams. Found: Ga_2O_3; 55·6, 56·0; calc., 56·9 per cent.

The salt forms transparent, microscopic crystals which are insoluble in water and ammonia, and soluble only with difficulty in acids; it is readily soluble in caustic alkalis.

Determination of Gallium with Cupferron.—Moser and Brukl (3) and Brukl (4) have shown that cupferron is an excellent precipitant for gallium, and, inasmuch as the process is carried out in acid solution, this method seemed the obvious one to use for the analysis of gallium phosphate. As the results quoted above indicate, however, the method seemed unreliable, because variations of several per cent. occurred on identical samples. In view of these results, it was decided to examine the method more closely.

A standard solution of gallium sulphate was made from pure gallium, and 10 c.c. of the solution was used for each determination. This volume contained 0·0892 gram of gallium oxide. In the first determinations, the procedure prescribed by the above authors was followed closely; the results were very low. Found: 0·0852, 0·0845 gram. The amount of cupferron was then increased to 1 gram for each aliquot which is almost twice the amount prescribed by the above authors. Found: 0·0892,

0·0890 gram. These results seemed excellent, but they were, in fact, no more than a coincidence, for further determinations gave, under the same conditions, 0·0876, 0·0885 gram. Reducing the acidity as suggested by van Bergkampf (6) to 0·5N gave 0·0876, 0·0868, 0·0878 gram.

These are typical results for a large number of determinations; some of them were obtained after nitric acid had been used to eliminate any possibility of reduction. The loss seems very definitely to be due to incomplete precipitation, for gallium was found in some cases in the filtrate when tested with tannin. The same gallium solution gave theoretical values when determined with hydroxyquinoline (Brukl, 4).

One point that needs to be particularly emphasised is the extremely hygroscopic nature of the oxide obtained by igniting the cupferron complex. It is in fact a matter of great difficulty to determine when constant weight has been achieved. If the oxide be kept overnight over phosphoric oxide, it actually gains 2 to 3 per cent. in weight; to reduce the weight again requires prolonged ignition at 1000°.

These facts have led us to the conclusion that cupferron is not a reliable reagent for the determination of gallium. It may be that more complete precipitation can be effected by increasing the proportion of cupferron used. Moser and Brukl dealt with quantities of the order of 0·03 gram of gallium only. It is our experience, however, that tannin is a better agent where it can be employed. The oxide obtained from it is not nearly so hygroscopic.

The tannin method developed by Moser and Brukl (7) was applied to the analysis of a few samples of crystalline gallium phosphate. The samples were dissolved in dilute caustic soda and acidified with hydrochloric acid. Tannin (0·5 gram) was added, and the acidity was reduced by adding a small excess of sodium acetate. The precipitate was filtered, dissolved in sulphuric acid, and re-precipitated after the addition of a little more tannin; it was washed with 1 per cent. ammonium sulphate and ignited to oxide. The phosphate in the filtrate was determined as magnesium ammonium phosphate, after destroying the tannin by fuming with sulphuric acid. Found: Ga_2O_3; 57·6, 57·8; P_2O_5; 43·2, 42·9; calc., 56·9, 43·1 per cent. Evidently, the tannin method is not satisfactory in the presence of phosphate.

Gallium Arsenate.—Attempts to make gallium ortho-arsenate by the same method which applied to the phosphate were not very satisfactory, for when the acid gallium solution was treated with excess arsenate and then made neutral to methyl red, the gelatinous precipitate first formed redissolved on standing. It was first thought that this was due to the presence of ammonium salts, but the same happened when arsenic acid was used and neutralisation was effected with caustic soda. There

appeared then to be two possible explanations: (*a*) that gallium arsenate forms complex arsenates with alkali arsenates; (*b*) that it is peptised by alkali arsenate.

Shortly after this observation was made, it was found that gallium arsenate does form complexes: the sodium complex salt is described below, but it is insoluble in water. The former explanation was thus rendered improbable. That the phenomenon was due to peptisation was supported by the behaviour of the solution on evaporation; a white solid appeared on the sides of the vessel as evaporation proceeded, and finally a horny mass remained. This horny mass was insoluble even in boiling arsenate solutions, and, moreover, it was found to contain all the gallium in the original solution. After washing as well as possible by grinding with water, the residue was found on analysis to contain almost exactly equimolecular proportions of gallium oxide and arsenic pentoxide. Thus the material peptised was actually gallium ortho-arsenate.

Amorphous Gallium Arsenate.—Pure gallium hydroxide, obtained from 0·75 gram of gallium by precipitation of gallium nitrate with ammonium

TABLE I.

Weight of sample.	Percentage loss at 280°.	Ga_2O_3 per cent.	As_2O_5 per cent.	Molec. ratio Ga_2O_3/As_2O_5.
0·2153	16·6	36·6	46·6	0·96
0·2070	16·2	35·8	45·4	0·97
* 0·1986	. .	38·2	44·5	1·05
* 0·1900	. .	37·7	43·1	1·07
$GaAsO_4.2H_2O$	14·8	38·3	47·0	1·00

carbonate, was suspended in 250 c.c. of hot water and titrated with molar arsenic acid; the precipitate gradually dissolved. At a certain stage, the gelatinous hydroxide disappeared and gave place to a small granular precipitate which would not dissolve with further additions of arsenic acid. As this residue probably contained some free gallium hydroxide it was discarded. The clear solution was evaporated slowly. A heavy granular solid commenced to separate almost immediately, and, when the volume had been reduced to 200 c.c., tests showed the liquid to be free from gallium. The solid was separated, washed, and analysed. Some of the results of the analysis of this substance are given in Table I. In the same table are the results of the analysis of another specimen, marked with *, prepared as follows: about 1·6 grams of gallium hydroxide was treated in the cold with excess of arsenic acid, the small precipitate was

filtered off, and the liquid was heated. Turbidity appeared at the hottest parts of the vessel, and this fact indicates that precipitation was not due to crystallation, but rather to coagulation of a colloid. The solid, granular and dense as before, was well washed with water and dried in the air.

These results are far from consistent, but this is not really surprising in view of the manner of formation of the precipitate. The second sample was probably contaminated with adsorbed arsenic acid, while the first one had possibly lost arsenic acid during the washing. Since the air-dried material probably also contained 1 or 2 per cent. of adsorbed water, the above analyses would indicate that the products made by the above methods were essentially the same, namely, the di-hydrate of gallium ortho-arsenate. A crystalline variety of this substance has been prepared and is described later. Several preparations by the above methods were made, but it was never possible to get satisfactory analyses; the arsenic values were low for reasons that will be given later.

When an equimolecular proportion of ammonium arsenate was used and the liquid was neutralised to methyl red, the gallium was only partly precipitated, and as basic arsenate; the remainder of the gallium remained in colloidal solution as arsenate. This fact, that gallium arsenate is so easily rendered colloidal, is one of great importance in connection with the extraction of gallium from sulphidic ores which generally carry arsenic, and it is dealt with at length below.

Crystalline Gallium Ortho-arsenate.—This was prepared by a method like that employed by Coloriano (8) for aluminium arsenate. A solution of 0·4 gram of gallium, as gallium nitrate, in 10 c.c. of water was heated in a sealed tube at 180° with rather less than an equimolecular proportion of sodium arsenate. (The reason for using a deficiency of sodium arsenate was that it had already been found that excess of the reagent gave a complex galli-arsenate. The tube, on cooling, contained a mixture of crystalline and gelatinous materials. This mixture was boiled with a solution of ammonium arsenate, when the gelatinous material dissolved completely; the residue was washed, first with a dilute solution of arsenic acid to prevent hydrolysis, and then with alcohol and ether. The air-dried product consisted of microscopic crystals whose form could not be definitely established; it was insoluble in hot and cold water, but it dissolved readily in caustic soda. After heating gently to remove water of crystallisation, it dissolved easily in acids, otherwise only with difficulty. Precisely the same product was obtained by heating gallium nitrate with an excess of pyroarsenic acid and water under the same conditions. Yield, after two hours' heating, 2 grams per gram of gallium. Found: (water), loss at 250°; 14·6, 14·6; Ga_2O_3; 38·5, 38·8; As_2O_5; 46·7, 46·2; calc. for $GaAsO_4.2H_2O$: water, 14·8; Ga_2O_3, 38·3; As_2O_5, 47·0 per cent.

Sodium Galli-arsenate.—Rosenheim and Thon (9) prepared a complex alumino-arsenate by heating together aluminium hydroxide, sodium hydroxide, and arsenic acid in the molecular ratio 1 : 10 : 20. A very similar galli-arsenate has been prepared as follows: 0·31 gram of gallium, dissolved in caustic soda (10 c.c. of 20 per cent. solution), was heated under pressure with 11·8 grams of pyroarsenic acid. After two hours at 180°, the micro-crystalline powder was separated, washed with small amounts of water, and air-dried. Yield, 1·6 grams. The filtrate and washings contained only a trace of gallium. Found: (water), loss at 120°; 2·5, 2·7; Ga_2O_3; 23·2, 23·6; As_2O_5; 57·1, 57·2; Na_2O; 7·8, 8·0; calc. for $NaH_2[Ga(AsO_4)_2].1\frac{1}{2}H_2O$: water, 2·3; Ga_2O_3, 23·5; As_2O_5, 57·5; Na_2O, 7·8 per cent.

The substance is insoluble in water and in ammonium hydroxide, but it is easily soluble in dilute caustic alkalis and in acids. At 120° it loses half a molecule of water; at 250° the loss is 10 per cent. by weight, which indicates that it is decomposed into a mixture of gallium arsenate and sodium meta-arsenate, while at 950° the substance is fused and the loss is considerably higher. After heating for half an hour at 950° the loss was 14 per cent. and the residue contained arsenic and gallium in the atomic ratio of 1·8. Evidently, arsenic is volatilised at this temperature. Furthermore, the product contained trivalent arsenic, because its solution in acid gave an immediate precipitate with hydrogen sulphide.

The substance may be represented as $NaH_2[Ga(AsO_4)_2].1\frac{1}{2}H_2O$ or as $Na[Ga(HAsO_4)_2].1\frac{1}{2}H_2O$. Rosenheim and Thon represent the corresponding aluminium compound as $NaH_2[Al(AsO_4)_2].\frac{1}{2}H_2O$, the complex ion being trivalent and in support of this formulation they were able to prepare a barium derivative to which they assigned the formula $BaH_4[Al(AsO_4)_3].H_2O$. Attempts to prepare the barium derivative of gallium arsenate proved fruitless, and since the sodium compound described above is insoluble it is not possible to say that one formula represents its constitution any better than the other.

When barium hydroxide was substituted for sodium hydroxide in the above preparation there was obtained almost a theoretical yield of gallium ortho-arsenate, di-hydrate.

Analysis of Gallium Arsenates.—The method adopted for the analysis of all the products that have been described was briefly the following: the sample was dissolved in about 50 c.c. of 2N sulphuric acid, heated to boiling, and arsenic was precipitated with hydrogen sulphide; the arsenic was then estimated by fuming with sulphuric acid and titrating with standard iodine, as described by Low (10). The gallium in the filtrate from the arsenic sulphide was estimated by the tannin method described by Moser and Brukl (7), except in the case of the galli-arsenate. The gallium was here precipitated with ammonia in presence of paper pulp, thus enabling sodium to be determined in the filtrate.

While this method gave results that leave no doubt about the nature of the substances described, it cannot be regarded as entirely satisfactory. The arsenic values, in particular, varied considerably; they were always low. The gallium figures, on the other hand, were generally a little high. These facts seemed to indicate that arsenic was incompletely precipitated by hydrogen sulphide: in a few instances, when the filtrate was put on one side after removing the arsenic, completely as it was believed, a small yellow precipitate appeared in the course of a few days. The problem could have been simplified by making the determinations on separate samples and distilling the arsenic in the presence of cuprous chloride, but it was considered desirable to estimate both arsenic and gallium in the same sample. In any case, the arsenic had to be removed before gallium could be estimated.

It is well known that precipitation of arsenious sulphide from arsenates is an extremely slow process. Reduction with sulphur dioxide and with hydriodic acid were tried, without, however, much success. Ultimately, a method of separation as silver arsenate was developed, and, though it is more cumbersome, it gave satisfactory results. Citric acid was used to maintain gallium in solution during the separation of silver arsenate. In regard to this method, the following points are of importance. It is not possible to weigh the silver arsenate, because it is contaminated with silver citrate; moreover, this silver citrate must be destroyed before arsenic is distilled as arsenious chloride; high results are obtained otherwise. In presence of citrates gallium is completely precipitated by tannin in strictly neutral solution only; if acetic acid be present, as recommended by Moser and Brukl, precipitation is incomplete. Citrates also interfere with the separation of silver chloride. The details of the method are as follows:—

The sample, dissolved in dilute caustic soda, was treated with $1\frac{1}{2}$ grams of citric acid, and the solution was made just acid to phenol phthalein. A small excess of silver nitrate was added, and the liquid was boiled for five minutes and cooled for an hour. It was filtered and then washed with water containing a few drops of silver nitrate. The precipitate was next dissolved in hot dilute sulphuric acid, transferred to a round-bottom flask, and taken to fumes of sulphur trioxide to destroy the citrate. It was then diluted, boiled to expel sulphur dioxide, treated with 2–3 grams of cuprous chloride, and distilled with hydrochloric acid. The filtrate from the silver arsenate precipitate was treated with hydrochloric acid and boiled; silver chloride was filtered off and the liquid was neutralised. Tannin was then added and the solution was again made neutral to methyl red. The gallium-tannin complex was filtered, washed once with water, dissolved in dilute sulphuric acid, and taken to fumes. The addition of a few drops of nitric acid at this stage ensured the destruction of the last trace

of organic matter. The liquid was then diluted and treated with a few drops of hydrochloric acid. The small precipitate of silver chloride was removed, and gallium was finally separated by adding tannin.

A sample of the crystalline ortho-arsenate previously described gave the following figures when analysed by this method: Found: Ga_2O_3; 38·0,

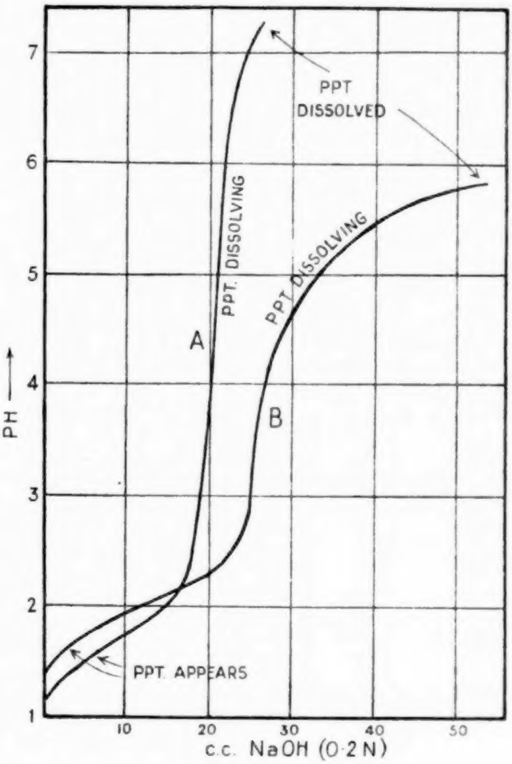


FIG. 1.

38·4; As_2O_5: 47·0, 46·7; calc. for $GaAsO_4.2H_2O$: Ga_2O_3, 38·3; As_2O_5, 47·0 per cent.

Conditions for Precipitation of Gallium in Presence of Arsenates.—It has been remarked already that gallium arsenate is peptised by arsenates under certain conditions; on the other hand, it has been obtained in fair yield by precipitation with arsenic acid. Hence, it would appear that complete precipitation of gallium arsenate can only be effected over a certain range

of acidity. Some potentiometric titrations were therefore made to determine the degree of acidity most favourable for complete precipitation.

0·0525 gram of gallium in dilute sulphuric acid was treated with arsenic acid and diluted to 50 c.c. Sufficient caustic soda was added to give a slight turbidity which was cleared with one drop of dilute sulphuric acid. The solution was then titrated with caustic soda (0·2N) and the change in pH was followed with the quinhydrone electrode.

Two such titrations were made, the results of which are plotted in fig. 1. Solution A (curve A) contained equivalent amounts of arsenic and gallium; solution B (curve B) contained four equivalents of arsenic for each equivalent of gallium. In both cases, precipitation commenced at pH 1·6 to 1·7 and continued while the pH value rose to about 3. At this point precipitation was complete, because in both cases further small additions of alkali caused a big change in pH. The precipitate then gradually dissolved, giving clear solutions at pH values 7 and 6 respectively. Excess arsenate, solution B, is evidently more favourable for precipitation, which is seen to be complete at pH 3; dissolution commences at pH 4 and is complete at pH 5·8. Clearly, therefore, in presence of arsenates gallium must be precipitated at pH 3 rather than at pH 5. The latter value is most satisfactory for gallium hydroxide.

Thymol blue and *p*-benzene sulphonic acid-azo-benzylaniline are suitable indicators which cover the pH range for satisfactory separation of gallium arsenate. Experiments carried out, using these indicators, showed that 97 to 98 per cent. of the gallium is precipitated. These facts have already been utilised by the authors in the development of a method of recovering gallium from alkaline extracts of the mineral germanite (1).

The authors wish to express their thanks to Prof. J. Smeath Thomas for the use of a sample of the mineral.

Summary.

Gallium ortho-phosphate has been prepared by neutralising a solution of a gallium salt in presence of a phosphate. The gallium is completely precipitated as a gelatinous phosphate. A crystalline variety has been prepared under pressure. Both forms are anhydrous.

The estimation of gallium in these substances and in pure gallium solutions by means of cupferron has been shown to be unreliable.

Gallium ortho-arsenate has been prepared in a similar way and both gelatinous and crystalline forms have been obtained. The arsenate separates as the di-hydrate.

A crystalline complex galli-arsenate has been prepared by using a large excess of arsenate in strongly alkaline solution under pressure.

The precipitation of gallium in presence of arsenates has been shown to be incomplete in neutral solution. The gallium arsenate is peptised. The conditions for complete separation have been investigated and good results are obtainable by precipitation at pH 3.

University, Cape Town.

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NOTES ON THE STRANDING OF A SCHOOL OF *PSEUDORCA CRASSIDENS* AT THE BERG RIVER MOUTH, DECEMBER 27, 1936.

By REAY H. N. SMITHERS, South African Museum, Capetown.

(With five Text-figures).

(Read July 21, 1937.)

On the 27th day of December 1936 there took place on the farm Varkvlei, some two miles south of the Berg River mouth, a further stranding of False Killer Whales, *Pseudorca crassidens*.* The object of this paper is to place on record as much information as possible concerning the event.

Owing to the absence of eye-witnesses there is no information available as to the actual act of stranding. It appears, however, that the whales were seen thrashing about between Varkvlei and the mouth of the river some days previous to the 27th.

The coastline in the vicinity is low-lying and rocky, the general outline being broken at intervals by a series of small sandy beaches. The water is shallow and at high tide it is possible to wade out 60 yards from high-tide mark.

On the 27th a strong off-shore wind was blowing (from the south-east) and, as is usual when this happens, the water for a distance of 300 yards from the shore was very discoloured, due to the surface layer of water being blown out to sea, bringing to the surface bottom water carrying quantities of fine silt which is dumped in this vicinity by the Berg River. A chart compiled by H.M.S.A. Surveying Ship *Protea*, under Commander J. Dalgleish, shows that, at a distance of approximately half a mile from the shore, the water at Mean Low Water Springs is only 4 feet deep (see fig. 5).

Unfortunately, owing to the difficulty of communication, the Museum authorities were not advised of the stranding until the 6th of January 1937, by which time many specimens had decomposed to such an extent that accurate measurements were impossible, while others had been cut up for biltong or had portions cut off for the extraction of oil.

* Two previous strandings are recorded in South Africa, at Kommetje, Cape Peninsula, December 1928, and Mamre, November 1935.

Diagrammatic Representation of Lengths.

Males.

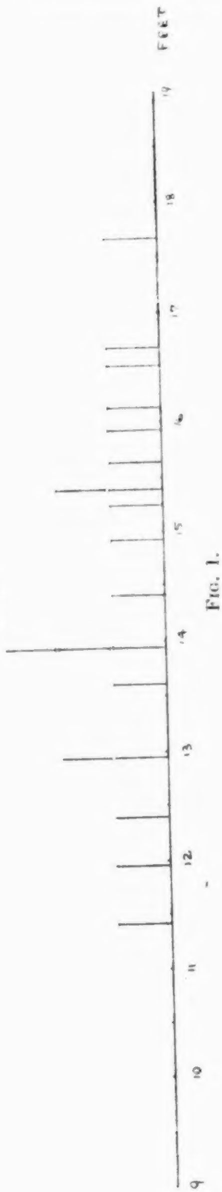

Fig. 1.

Diagrammatic Representation of Lengths.

Females.

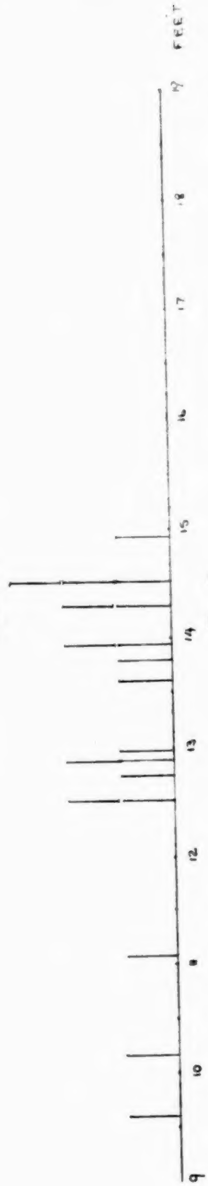

Fig. 2.

All the whales were lying on or about the high-water mark and the majority showed distinct signs of their frenzied flounderings over the sharp rocks, their bodies being covered with jagged cuts. There seemed to be two distinct parties, the first lying in Bay A (see fig. 4) and to the east of the bay on the headland, the second about a mile to the east of this headland in the corner of a small sandy bay B.

It is interesting to note that of the twenty-one lying in Bay A some 75 per cent. were males; while, in Bay B, of the fifteen whose sex was determinable, ten were females. Of those lying on the headland 60 per cent. were females.

Morphological Observations.

Particulars of measurements are given.

Size Groups.—Figs. 1 and 2 give a diagrammatic representation of the data recorded. Their correspondence to the data recorded by Professor Peacock in his paper on the stranding in the Tay estuary * is quite clearly marked. In this case, however, on an average the whales are smaller, the group of large male specimens varying from approximately 14 feet 6 inches, with a few grouping themselves around 12 to 13 feet. (Males measuring over 19 feet in total length were present in the two previous strandings in South Africa at Kommetje and Mamre.)

Among the females the grouping is rather more marked, the largest natural group varying in length from 13 feet 6 inches to 15 feet, the smaller from 12 feet 6 inches to 13 feet.

While in Professor Peacock's paper the data show the males to average approximately 3 feet larger than the females, in this case it appears that, on the whole, the males are only some 18 inches to 2 feet larger.

Foetus.—Owing to the advanced state of decomposition only one foetus was found, measuring 1 foot 11 inches. A small sucking calf was found measuring 5 feet 2 inches, details of further measurements being given in the accompanying table.

The fact that the foetus was taken from a female measuring 12 feet 5 inches (No. 54) tends to bear out Professor Peacock's suggestion that the females become sexually mature before full growth is attained.

Allometry.

Details of ratios are given as follows: Total length to snout-forelimb length; total length to snout-eye length.

* Professor A. D. Peacock, L. Comrie, and F. Greenshields, Scottish Naturalist, July–August 1936.

Teeth.

Owing to the fact that large numbers of teeth had been taken by sightseers, accurate details of only thirty-eight specimens were available. Details are set out in the tables provided.

In this case it would appear that the typical formula is $\frac{9}{9}$, although there is a wide series of formulae from $\frac{7}{8}$ to $\frac{9}{10}$.

The Stranding.

Many theories have been advanced to explain the appearance of *Pseudorca* on the shore in South Africa. In the light of this particular

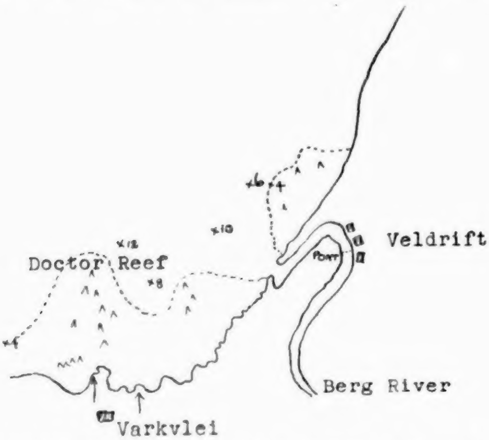

Fig. 3.—Sketch of the Berg River mouth to show position of the farm Varkvlei. Ocean depths in feet calculated from Mean Low Water Springs. The arrows mark the positions of the stranding.

occasion it would appear that, as in the case of the Mamre stranding, at least a portion of the school came ashore in a small bay with an obstruction across part of the mouth; in this case a rocky reef covered with weed. In the case of the Mamre stranding the obstruction was more apparent in the form of a definite sand bar, covered at low tide, but nevertheless sufficient to cause inconvenience to a whale of the size of the *Pseudorca* which came ashore. It is possible that the school made their way into the small bay and became excited at finding themselves in an apparently landlocked water; those that, in their mad rush, made for the bar were able to fight their way over and regain deep water, while those that set off landwards became stranded. It was suggested that in this case sharks

had attacked the school, as a few were washed up at the same time. These "sharks," however, turned out to be common dogfish, a species of *Mustelis*, and as the largest was only about 3 feet 6 inches long, and as, in any case, this genus is only equipped with nodular teeth, it is highly unlikely that they could have been the cause.

Sand in the blowhole has also been suggested as a cause. Now, although the water in this neighbourhood is extremely dirty through causes already explained, the material in suspension is very fine and could hardly cause irritation.

ALLOMETRY.

Males.

Ratio $\frac{\text{Total Length}}{\text{Snout-Forelimb}}$

Length . .	11′ 5″	12′ 4″	12′ 10″	12′ 11″	13′ 7″	13′ 9″	13′ 10″
Ratio . .	5·5	5·1	5·5	5·6	5·7	5·7	5·7
Length . .	14′ 4″	15′ 4″	15′ 11″	16′ 1″	16′ 5″	16′ 6″	17′ 7″
Ratio . .	5·7	5·9	6·0	6·0	6·0	6·0	6·3

Conclusion as in the case of the females.

Ratio $\frac{\text{Total Length}}{\text{Snout-Eye}}$

Length . .	11′ 5″	12′ 4″	12′ 10″	12′ 11″	13′ 7″	13′ 9″	13′ 10″
Ratio . .	9·1	8·3	9·1	9·1	9·1	9·2	8·5
Length . .	14′ 4″	15· 4″	15′ 11″	16′ 1″	16′ 5″	16′ 6″	17′ 7″
Ratio . .	9·0	9·9	10·1	10·2	10·4	10·4	10·5

Females.

Ratio $\frac{\text{Total Length}}{\text{Snout-Forelimb}}$

Length	9′ 6″	12′ 5″	12′ 5″	12′ 8″	12′ 9″	12′ 10″	13′ 7″	13′ 10″	14′ 3″	14′ 6″	14′ 9″
Ratio	4·9	4·7	5·7	5·4	5·3	5·3	5·6	5·7	5·7	5·6	6·1

On the whole this shows an upward trend indicating a more rapid growth behind the forelimb than in front of it, as in the case of the stranding in the Tay Estuary.

Ratio $\frac{\text{Total Length}}{\text{Snout-Eye}}$

Length	9′ 6″	12′ 5″	12′ 5″	12′ 8″	12′ 9″	12′ 10″	13′ 7″	13′ 10″	14′ 3″	14′ 6″	14′ 9
Ratio	7·9	8·3	8·8	8·9	8·7	9·1	9·1	9·5	10·7	9·2	11·1

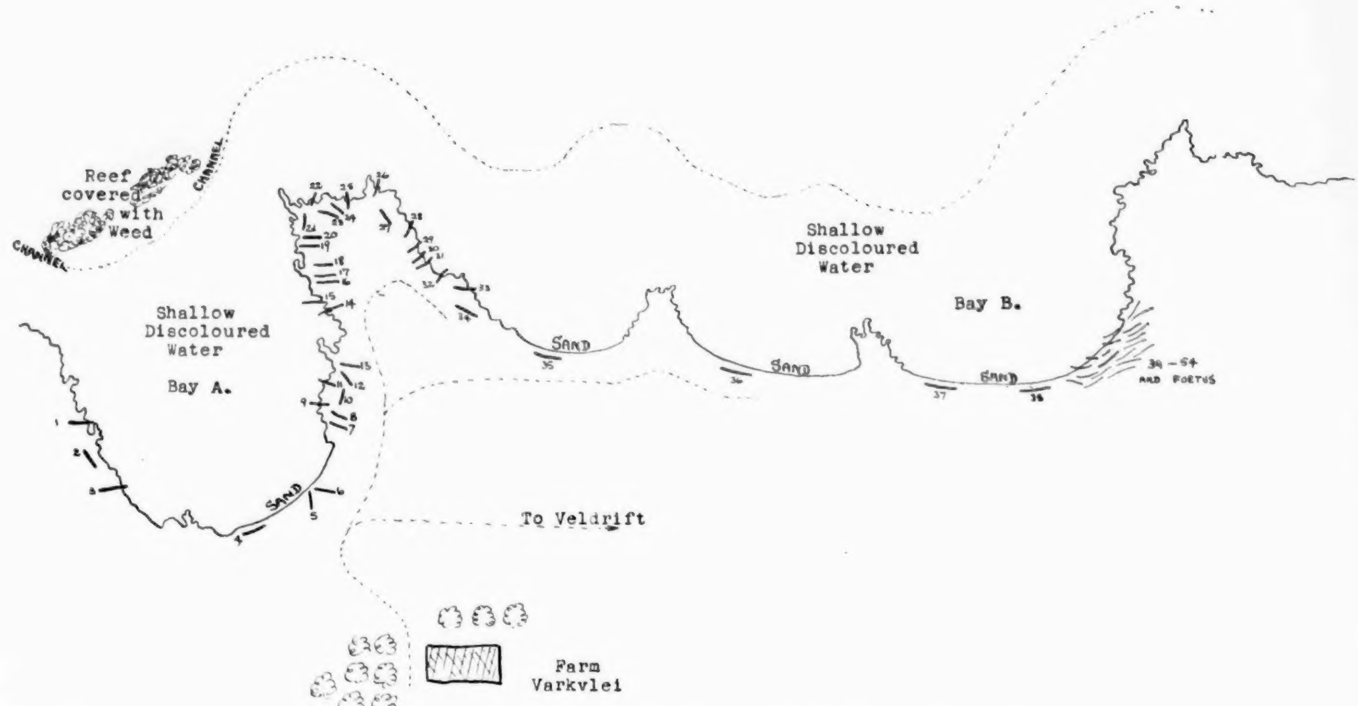

FIG. 4.—Positions of false killers 1–54 on stranding. Scale 1″ = approximately 140 yards.

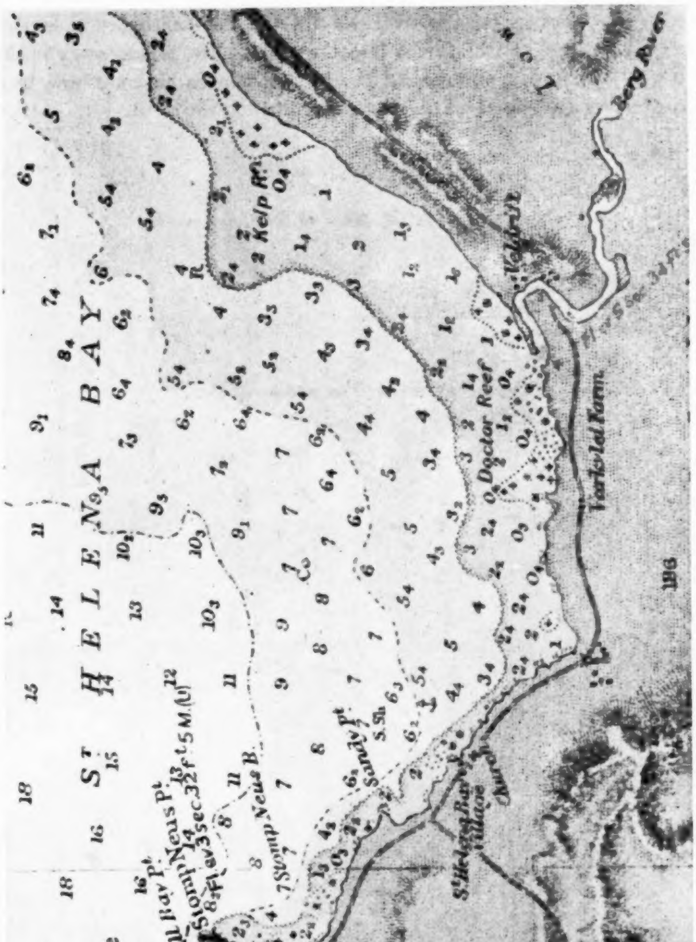

FIG. 5.—Showing shallow water to some distance from the shore and the position of the Doctor Reef. (From Admiralty Chart of the Berg River mouth.) Scale 1" = 2 English miles.

The falling away in the upward tendency of this ratio as noticed in the specimens in the Tay Estuary is not noticeable here, although there seems to be a tendency in females over 14′ 3″, the non-continuation of this decrease being due to insufficient measurements. The falling away in the ratio was explained in the case of the Tay specimens as being due to a slowing up of the growth of the bones constituting the skull.

DENTITION.

Dental Formula of Berg River Specimens.

	$\frac{7}{8}$	$\frac{8}{8}$	$\frac{9}{8}$	$\frac{8}{9}$		$\frac{8}{10}$	$\frac{9}{10}$
Males . .	..	1	..	5	6	2	5
Females .	1	1	1	2	4	1	1
Total .	1	2	1	7	10	3	6

Dental Formula irrespective of Sex.

	$\frac{7}{8}$	$\frac{8}{8}$	$\frac{9}{8}$	$\frac{8}{9}$	$\frac{9}{9}$	$\frac{8}{10}$	$\frac{9}{10}$
Total .	1	2	1	10	11	5	8

Measurements and Number of Teeth of Pseudorca crassidens stranded at the Berg River mouth, December 27, 1936.

Number.	Sex.	Length in feet and inches.	Number of upper teeth.	Number of lower teeth.	Snout to forelimb, inches.	Length forelimb, inches.	Height forelimb, inches.	Snout to dorsal fin, inches.	Height of dorsal fin, inches.	Snout to angle mouth, inches.	Snout to eye, inches.	Snout to blowhole, inches.	Snout to urogenital opening, inches.	Snout to anus, inches.	RH tail fluke, inches.	LH tail fluke, inches.	
1	..	15′ 3″	9	10	28	20	..	76	11½	12	17	18	108	..	15	16	
2	M.	12 4	8	10	29	17	..	64	10	14	18	19	88	..	14	13	
3	..	15 0	8	9	32	21	..	77	..	14	19	21	..	..	18	17	
4	M.	16 1	8	9	32	24	..	79	..	15	19	20	106	116	18	19	
5	F.	13 7	7	8	29	16	..	68	..	14	18	18½	103	..	15	16	
6	F.	9 6	9	9	23	12	..	52	7½	11	14½	15½	..	..	10	11	
7	M.	14 4	9	10	30	21	8½	70	..	15	18½	19½	98	106	16	15	
8	M.	15 4	9	9	31	21	8½	72	14	15	18½	18	102	108	17	17	
9	M.	16 5	9	10	32	24	8½	75	16	14	19	19	107	121	18	17	
10	F.	12 8	8	10	28	16½	6½	66	10½	13	17	17	100	106	13	14	
11	M.	14 4	9	9	30	21	8½	69	13	15	18½	19	99	107	17	18	
12	M.	13 9	9	9	29	19	8	68	11½	12	18	19	94	105	13½	15½	
13	M.	13 9	8	8	30	21	8	70	12	14	18	19	97	110?	15½	16½	
14	M.	16 6	9	10	33	24	9½	82	..	15	20	..	118	136	19½	18	
15	..	13 10	..	..	25	18	8	71	14	14	17	16	..	..	18	19	
16	M.	17 7	8	9	34	23	8	79	14	18	21	20	115	136	17	19	
17	F.	12 5	8	9	30	18	7	71	13	15	18	19	107	113	15	15½	
18	..	13 10	9	9	28	17	..	..	..	12	15	16	..	..	14	13	
19	..	13 6	8	9	31	18	7½	67	10	14	17	19	99?	117?	14	13	
20	M.	13 7	9	9	29	18	9½	67	11	14	18	18	..	110	14	15	
21	..	13 7	9	10	28	21	8½	72	10	14	17	17	..	..	14	13	
22	M.	11 5	8	9	27	14	6	57	9½	12	15	17	79	93	11	12½	
23	..	11 5	8	9	..	15	6	58	9	13	17	17	..	..	..	..	
24	F.	14 9	9	9	29	16	8	72	10	12	16	16	..	..	14½	14	
25	M.	15 7	9	10	30	20½	9	72	11½	14	18	18	108	127	17	17	
26	..	12 5	8	10	29	17	8½	68	10	13	18	19	..	..	14½	13	
27	M.	13 10	9	9	31	21	8½	68	12	15	19½	19½	92	110	16	16	
28	M.	15 11	8	10	31	19	9½	69	14	14	18½	18½	104	122	18½	17½	
29	F.	14 3	8	8	30	17	10½	71	12	12	16	18	110	115	15	14	
30	..	14 8	..	..	33	18	10	74	14	15	19	18½	..	..	16	17	
31	F.	12 9	9	10	29	17	7	65	11	14	17½	17½	98	103	13	14	
32	F.	12 10	9	9	29	15	7½	65	10½	12½	17	17	98?	..	14½	15	
33	F.	14 6	..	..	31	19	9	75	10½	14	19	18½	105	..	16	15	
34	F.	14 6	9	8	30	18	10	74	11	13	17	18	114?	..	17	16	
35	M.	15 4	9	9	31	22	9½	..	..	14	18	22	104	118	18	17½	
36	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
37	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
38	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
39	M.	12 11	8	9	30	19	8	68	11	14	17	19	93	107	15	15	
40	..	13 10	8	10	..	..	..	..	..	..	..	..	..	..	..	..	
41	M.	14 5	9	10	31	21	8½	67	15	14	18	18	98	112	19	18	
42	M.	12 10	8	9	28	17	7¾	..	..	13	17	..	92	106	13½	13½	
43	F.	13 10	8	9	29	18	7	71	..	14	17½	19	..	100	14	15	
44	..	5 2	?	9	14½	8½	3	29	4½	7	8½	8½	..	40	4	6	Suckling
45	M.	14 9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
46	F.	13 11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
47	F.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
48	..	14 8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
49	..	9 11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
50	M.	11 10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
51	F.	12 9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
52	F.	14 5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
53	F.	13 11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
54	F.	12 5	9	9	26	15½	7½	58	..	12	17	16	87?	..	14½	12	
55	F.	11 1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
56	..	14 10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
57	F.	14 3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
58	F.	10 3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	

Foetus—1′ 11″. From No. 54.

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TRANSACTIONS

OF THE

ROYAL SOCIETY OF SOUTH AFRICA.

VOL. XXV.

MINUTES OF PROCEEDINGS.

Anniversary Meeting.

The Anniversary Meeting of the Society was held on Wednesday, March 18, 1936, at 8.15 p.m., in the Board Room of the South African Association, Church Square, Cape Town.

The President, Dr. A. W. Rogers, was in the Chair.

Business:—

Report of the Honorary General Secretary for the year 1935. It was agreed that the following two items be added:—

"At the Meeting of the Society held on March 20, 1935, the President, Dr. A. W. Rogers, delivered an address on the Solid Geology of the Kalahari. Professor Crawford proposed a vote of thanks."

"The Society records with regret the death of Dr. Marius Wilson. Dr. Wilson had been a Member of the Society since 1903, and a Fellow since 1909."

The remainder of the Report was passed.

On the motion of Professor Andrew Young, and arising from the Report, the meeting agreed that Council should correspond with the Soviet Representative in Johannesburg, with a view to continuing exchanges with Russia.

The Report of the Honorary Treasurer was passed.

Election of Council:—

Messrs. Naudé and Copenhagen were appointed as Scrutineers. The following were elected as Council for 1936:—

President, L. Crawford; Hon. Treasurer, A. Brown; Hon. General

Secretary, A. J. H. Goodwin; Hon. Editor of Transactions, R. S. Adamson; Hon. Librarian, E. Newbery; Council, K. H. Barnard, H. G. Fourcade, J. Jackson, R. F. Lawrence, E. P. Phillips, A. W. Rogers, B. F. J. Schonland, R. B. Young.

Professor H. Stephen, having ceased to be a Fellow, fails to be elected. Under the old Statutes two additional names were proposed; these will be recognised by Council in replacing Professor Stephen.

The President announced that the Revised Statutes would come into effect this Session.

Presidential Address, "The Superficial Deposits of the Kalahari."

Ordinary Meeting.

The Anniversary Meeting was followed by an Ordinary Meeting.

The President, Dr. L. Crawford, took the Chair.

Business:—

The Minutes of the Meeting held on Wednesday, October 16, 1935, were confirmed.

The selection of Vice-Presidents was deferred until the next meeting.

W. S. Rapson and I. Donen were elected to Membership of the Society.

The following were nominated to Membership of the Society:—W. E. Isaac, proposed by R. S. Adamson, seconded by Mrs. M. Levyns; J. H. Pringle, proposed by J. Hewitt, seconded by J. L. B. Smith; A. F. Spilhaus, proposed by A. Brown, seconded by L. Crawford; N. Sutherland, proposed by E. Newbery, seconded by A. J. H. Goodwin.

The Secretary read the replies given to a Deputation from the General Purposes Committee, University of Cape Town. The deputation formulated the following questions:—

1. Is the Royal Society willing to assure those interested in Humanistic studies that it will publish material in those studies?

2. Would the Royal Society consider the publication of a Monograph series separate from the Transactions; alternatively, would the Society consider separate publication of papers published in the Transactions?

3. Would the Society be willing to identify series of Monographs with the body represented by the writers of such a series?

The deputation agreed to represent to the University the need for subsidising publications. The deputation then retired. After further discussion the Council agreed to the following answers:—

1. The Society is prepared to consider for publication papers on Humanistic studies on the same basis as it considers other papers.

The Society is desirous that this should be made known. In view of the possible increase of material submitted for publication and the increased expenditure required, some further income is necessary. One source of such income would be an increase in the number of members, particularly those interested in Humanistic studies.

2. Instead of undertaking the publication of separate monographs, the Society considers that it would be an advantage if individual papers were made separately available, and is considering this matter.

3. The Society is prepared to specify the title and source of a paper in such a way as to identify it as one of a series emanating from a particular institution or group. This has been done in the past.

These replies have been communicated to the General Purposes Committee, and their opinion is awaited.

Communications:—

"The Relationship between Winter Rainfall and Barometric Pressure, Barometric Tendency and Wind Direction at Cape Town," by H. E. Morrison and J. T. Morrison.

"A Study of the Aspiration Psychrometer," by A. F. Spilhaus (communicated by A. Brown).

"The Archaeology of the Florisbad Deposits," by T. F. Dreyer.

The various "eyes" at the Florisbad spring have now yielded the following deposits containing implements:—

1. Sand cap in the Green Sand layer. Implements from here approximate to the fluted flake technique, but are not yet of this type. The Florisbad skull fragments are from this layer.

2. The sand cap is closed by Peat III, and implements from this deposit show well-formed triangular fluted flakes, such as are also found in the Green Sand.

3. Long points have been found from Peat III, and the associations with this previously known implement are probably predominating long flakes with fewer triangular flakes.

Evidence indicates that the local development of the fluted flake is older than the coastal development, and that it was here synchronous with the development of the Stellenbosch elsewhere. The evidence is based upon the absence of bone tools, the presence of numerous extinct mammalian fossils, and the distribution of implement types.

"The Archaeological Succession of the Natural Deposits at Plettenberg Bay and Mossel Bay," by T. F. Dreyer.

The relative age of various deposits at Plettenberg Bay and Mossel Bay is discussed. It is deduced that there are a black surface layer, a layer of red sand, and an intercalated reddish yellow layer. This latter contains implements of late Stellenbosch type. At Plettenberg Bay this series

overlies a white sand (karringmelk grond) which yields Stellenbosch types.

It is presumed that the pre Red Sand deposits are synchronous at the two places. If this is so, the implements of the lime talus at Mossel Bay would be older than those in the white sands at Plettenberg Bay, which is further indicated by typology.

"The Chromosome Numbers in the Genus *Berberis*," by M. H. GIFFIN.

"Contribution to the Study of *Dichapetalum cymosum* and the Ecology of the Transvaal Veld," by A. C. LEEMANN.

"South African Native Ceramics," by P. W. LAIDLER.

A. J. H. GOODWIN,
Hon. General Secretary.

Ordinary Meeting held on Wednesday, April 15, 1936.

The President, Dr. L. CRAWFORD, was in the Chair.

Business:—

The Minutes of the Meeting held on Wednesday, March 18, 1936, were confirmed.

The following were elected to Membership of the Society:—W. E. ISAAC, J. H. PRINGLE, A. F. SPILHAUS, N. SUTHERLAND.

The President nominated Dr. K. H. BARNARD and Professor R. B. YOUNG as Vice-Presidents of the Society for 1936. The co-option of Professor C. VAN RIET LOWE to the Council, in place of Professor STEPHEN, was announced.

Communications:—

"Some Observations on *Opuntia* used as a Larvicide," by F. G. CAWSTON.

An investigation is made of the claim that *Opuntia vulgaris* produces a substance which is superior to chemicals in the destruction of mosquito larvae. The mucilage of *Opuntia maxima* was tested in various degrees of concentration and the effect carefully studied on four different anophelines and Culex. It was found that the majority of the larvae rapidly succumbed, but that the mucilage had little effect on those which had reached the pupal stage. There was also an arrest of development of those which were subsequently removed to clean water. Consideration of the specific gravity indicates that the juice even in the fresh state has little influence on surface organisms and a study of the chemical composition of various species of *Opuntia* indicates that the effect is largely a mechanical one, whilst a preservative is needed to prevent decomposition.

"History of the Ba-ga-Malete of Ramoutsa," by VIVIEN ELLENBERGER (communicated by A. J. H. GOODWIN).

"Acculturation among the BaKxatla," by I. SCHAPERA.

"Some Diatoms from the Victoria Falls," by FLORENCE RICH (communicated by Miss E. L. STEPHENS).

"Use of Serum as an Accessory Medium in Tissue Culture," by W. S. S. LADELL.

"A Revised Simple Technique for the Frog Test," by H. ZWARENSTEIN.

"The Pancreas and Blood Inorganic Phosphorus," by V. SCHRIRE and H. ZWARENSTEIN.

The normal plasma inorganic phosphorus content of Xenopus is 7·1 mg. per 100 ml. (average of 58 estimations). Temperature has no effect. Pancreatectomy caused a 30 per cent. increase six hours after operation. Injection of insulin into normal animals caused a 50 per cent. drop four hours after injection.

A. J. H. GOODWIN,
Hon. General Secretary.

Ordinary Meeting held on Wednesday, May 20, 1936.

The President, Dr. L. CRAWFORD, was in the Chair.

Business:—

The Minutes of the Meeting of Wednesday, April 15, 1936, were confirmed.

The names of the Candidates submitted to Council for Fellowship were announced.

JANET C. MACLAGAN was nominated for Membership of the Society. Proposed by R. S. ADAMSON, seconded by M. R. LEVYNS.

Communications:—

"Notes on the Genus *Stoebe*," by Mrs. M. R. LEVYNS.

Stoebe falls into two well-marked sections based on distinct types of floral structure. One type is widespread in Africa and extends to Madagascar and Reunion. Distribution of species of this type is predominantly discontinuous. The other type (comprising most of the species) is almost confined to the South-West Cape and the species have, with few exceptions, a restricted and continuous distributional range.

The distribution of species in this genus supports the view that the south-western flora at one time occupied a much larger area than it does to-day. Evidence appears to indicate that *Stoebe* had its origin somewhere in central Africa and migrated southwards. In common with most elements of the Cape flora the species of *Stoebe* are concentrated in the south-western corner of Africa.

The interpretations that may be placed on these facts of distribution

were discussed and reference was made to similar types of distribution in other genera such as *Lobostemon*, *Passerina*, etc. It was suggested that work in progress on phenology and cytology may throw light on problems of distribution in southern Africa.

"Fishes new to South Africa," by J. L. B. Smith.

A. J. H. Goodwin,
Hon. General Secretary.

Ordinary Meeting held on Wednesday, June 17, 1936.

The President, Dr. L. Crawford, was in the Chair.

Business:—

The Minutes of the Meeting of Wednesday, May 20, 1936, were confirmed.

Miss J. C. Maclagan was elected to Membership of the Society.

Communications:—

"Mercurous Perchlorate and the monovalent Mercurous Ion," by E. Newbery.

"Rock Engravings in the Vaal River Basin," by C. van Riet Lowe.

"Studies in the Inorganic Metabolism of the Kelsey and Gaviota Plums: I. Potassium," by L. N. Cohen.

A. J. H. Goodwin,
Hon. General Secretary.

Ordinary Meeting held on Wednesday, July 15, 1936.

The President, Dr. L. Crawford, was in the Chair.

Business:—

The Minutes of the Meeting of Wednesday, June 17, 1936, were confirmed.

The following were nominated to Fellowship of the Society:—A. Galloway, proposed by R. A. Dart, F. M. Watt, H. H. Paine, E. L. Gill; S. M. Naudé, proposed by J. T. Morrison, J. Smeath Thomas, Sir J. C. Beattie, T. A. Stephenson; J. L. B. Smith, proposed by J. Hewitt, S. Schonland, T. A. Stephenson, E. L. Gill; N. J. G. Smith, proposed by R. H. Compton, E. L. Stephens, M. R. Levyns, T. A. Stephenson; H. Zwarenstein, proposed by W. A. Jolly, J. W. C. Gunn, B. J. Ryrie, I. Schapera.

Communications:—

"Women's Initiation Among the Mpondo," by J. S. GRIFFITHS (communicated by A. J. H. GOODWIN).

Descriptions from native sources and observation of the ceremonies observed at the initiation from girlhood to womanhood among the Mpondo.

"The Mpondo Regimental System," by A. J. H. GOODWIN.

An account of the regimental system of the royal houses of the Western Mpondo.

A. J. H. GOODWIN,
Hon. General Secretary.

Ordinary Meeting held on Wednesday, August 19, 1936.

The President, Dr. L. CRAWFORD, was in the Chair.

Business:—

The Minutes of the Meeting of Wednesday, July 15, 1936, were confirmed.

The President moved that the Society record its deep regret at the death of Sir ARNOLD THEILER, Honorary Fellow of the Society, and a scientist of world-wide repute; and the Society's sincere sympathy with Lady Theiler. It was resolved that a copy of this resolution be sent to Lady Thieler.

G. P. LESTRADE was nominated to Membership of the Society: proposed by A. J. H. GOODWIN, seconded by I. SCHAPERA.

Demonstration:—

"Extensometer for use on Steel Bands or small Cross-section," by J. A. GILMORE.

The steel bands referred to in the accompanying note are of small section and fairly hard. An extensometer for use on this type of band requires to be light and to have some means of attachment which does not damage the surface of the metal to avoid initiating fracture at the point of clamping. The extensometer designed for use on small section specimens of this type consists of two pairs of hardened steel knife edges which are attached to the specimen at any convenient gauge length from $1\frac{1}{2}$ inches to 10 inches. The opposite parts of a pair are held together by clamping screws and grip the steel band between them, the actual knife edges registering exactly opposite one another. A pivoted lever on the upper pair of knife edges is connected to the lower pair of knife edges by a light adjustable connecting bar. Various degrees of magnification are available. The measurements may be made either by the scale and mirror method,

using a mirror attached to the same pivot as the lever, or by an extension on the lever, if a graphical record is desired. The instrument was made in the workshop of the Civil Engineering Department of the University of Cape Town.

Communications:—

"Young's Modulus for Steel Surveying Bands," by J. A. GILMORE.

Steel bands hanging in catenary loops between supporting stands are employed in Jaderin's method of measuring base lines. The precision and convenience of the method will probably cause it to be widely adopted both for primary and secondary bases. An investigation into the technique of using bands in this way is at present being carried on in the Surveying and Civil Engineering Departments of the University of Cape Town. This includes work on the supports and tensioning devices, the measurement of temperature, the comparison with standards and the determination of the thermal and elastic properties of the steel bands used. An extensometer, described in the accompanying note, was used for finding the elastic constants. For steel bands approximately $\frac{1}{8}$ inch wide by $\frac{1}{64}$ inch thick, it was found that the yield-point occurred at a stress in the neighbourhood of 53 tons per square inch, while the ultimate stress was approximately 108 tons per square inch. (Tons of 2240 lb. used.) The value of Young's Modulus for the same steel was found to be 28,000,000 lb. per square inch.

"Some Studies of 50 Cycle Wave-forms in Insulation Testing," by N. H. ROBERTS (communicated by E. NEWBERY).

"A Device for the Superposition and Simultaneous Delineation of Two Wave-forms on a Single Cathode Ray Oscillograph Screen," by N. H. ROBERTS (communicated by E. NEWBERY).

"Rock Engravings near Beaufort West," by W. G. SHARPLES.

"Studies in South African Algae: I. Hydrodictyon in South Africa," by M. A. POCOCK.

A. J. H. GOODWIN,
Hon. General Secretary.

ANNUAL MEETING.

Annual Meeting of the Society held on Wednesday, September 16, 1936.

The President, Dr. L. CRAWFORD, was in the Chair.

Business:—

Election of Fellows: The following were elected Fellows of the Society:—ALEXANDER GALLOWAY; S. MEIRING NAUDÉ; JAMES LEONARD BRIERLY SMITH; NOEL JAMES GILLIES SMITH; H. ZWARENSTEIN.

The Annual Meeting was followed by an Ordinary Meeting.

Business:—

The Minutes of the Ordinary Meeting of August 19, 1936, were confirmed.

G. P. Lestrade was elected to Membership of the Society.

Communications:—

"The External Sexual Characters of South African Harvest Spiders," by R. F. Lawrence.

"Some French Historical Sources used by Sir Walter Scott. I. Quentin Durward," by D. Inskip (communicated by A. J. H. Goodwin).

"Some Notes on the Political Organisation of certain Xhosa-speaking Tribes in the Transkeian Territories," by G. P. Lestrade (communicated by I. Schapera).

"Anomalous Secondary Thickening in Osteospermum," by R. S. Adamson.

A. J. H. Goodwin,
Hon. General Secretary.

Ordinary Meeting held on Wednesday, October 21, 1936.

The President, Dr. L. Crawford, was in the Chair.

Business:—

The Minutes of the Ordinary Meeting of September 16, 1936, were confirmed.

S. M. Naudé and H. Zwarenstein were admitted to Fellowship of the Society.

Council:—

The Council recommended the following for election to the Council for 1937:—

President, L. Crawford; Hon. Treasurer, A. Brown; Hon. General Secretary, A. J. H. Goodwin; Hon. Editor of Transactions, R. S. Adamson; Hon. Librarian, E. Newbery; Council, E. L. Gill, J. Jackson, R. F. Lawrence, S. M. Naudé, A. Pijper, B. J. Ryrie, B. F. J. Schonland, J. L. B. Smith, R. B. Young.

Communications:—

"The Effects of Oil-sprays on the Transpiration of Peach Twigs," by G. D. B. de Villiers and S. M. Naudé.

Delayed foliation and die-back of fruit trees may be ascribed to an abnormal development of the fruit and leaf buds. Research of Mally, Reinecke, and Black has revealed that delayed foliation is minimised

by spraying the trees in August and early September with emulsions of certain oils.

In the present work it is found that oil-sprays diminish the transpiration of twigs by about 50 per cent. This indicates that the effect of the oil is to close the lenticels of the twigs and buds partly and thus the oil prevents excessive transpiration. Further, it is found that the twigs sprayed with oil build up a greater reserve of sap than the unsprayed twigs. Hence when the buds open up, less danger exists of their drying out and the phenomena of delayed foliation and die-back occurring. A screen placed on the north side of a peach-tree lowers the radiation and the air temperatures to which the tree is exposed and increases the relative humidity of the atmosphere surrounding the tree. These conditions tend to decrease the transpiration of the screened tree in comparison with the unscreened tree. This may account for the observation that trees which are sheltered from the sun's rays in winter by screens or windbreaks develop more normally than unsheltered trees.

The discoloration of peach twigs is found not to be due to the sun's heat rays, as is generally assumed in literature, but to be caused by the ultra-violet rays of wave-length less than 3500 Å. which are absorbed by glass.

The investigation is being continued.

"Studies in Deciduous Fruit. IV. On the Distribution of Nitrogenous Fractions in the Pulp of the Kelsey Plum (*Prunus salicina*)," by I. Donen.

"Studies in Deciduous Fruit. V. Preliminary Observations on the Relationship between Nitrogenous Metabolism and Internal Breakdown of Kelsey Plums in Cold Store," by I. Donen.

"A Middle Stone Age Site at Tygerberg, near Prince Albert," by W. E. Sharples.

"The South African Inter-tidal Zone in its relation to Ocean Currents. I. A Temperate Indian Ocean Shore," by T. A. Stephenson, A. Stephenson, and C. A. du Toit.

"Experimental Induction of Ovulation," by H. Zwarenstein.

Injection of the benzoic acid ester of dihydro-oestrone (Progynon Boleosum forte) plus progesterone (proluton) or of progesterone alone causes ovulation in normal and in hypophysectomised frogs. The presence of dihydro-oestrone or of the anterior pituitary gland seems to be unnecessary for the ovulating effect of progesterone. Large numbers of both mature and immature eggs are extruded by the ovary.

The oviducts secrete large amounts of a sticky jelly-like material. Ovulation is associated with swelling and hyperaemia of the anal labia. This effect is very much more pronounced with dihydro-oestrone plus progesterone than with progesterone alone.

"Combined Oscillographic and Camera Studies of Lightning," by B. F. J. Schonland, D. B. Hodges, and H. Collens.

A combination of the cathode-ray oscillograph with the Boys camera enables the luminosity changes in the lighting channel to be related to corresponding electrical changes.

The results indicate that the leader process in all cases observed lowers a negative charge towards ground. The stepped leader involves an intermittent decrease of negative electric moment with corresponding radiation in the form of a ripple which always precedes the main radiation field caused during the return stroke. The dart leader process involves a continuous decrease in moment.

Discharges taking place in a thundercloud are less important sources of atmospherics than those passing to ground and are probably insignificant in effect at considerable distances. Evidence has been obtained of reflection of atmospherics from the ionosphere.

A. J. H. Goodwin,
Hon. General Secretary.

Report of the Hon. General Secretary for 1935.

Eight Ordinary Meetings, the Annual Meeting, and the Anniversary Meeting were held during the year, and the undermentioned papers were read:—

1. "Studies in Deciduous Fruit. II. The Effect of Time of Picking on Chemical Changes in Store of the Kelsey and Gaviota Plums," by I. Donen (communicated by J. Smeath Thomas).

2. "The Organic Matter Content and Carbon-Nitrogen Ratio of South African Soils of the Winter Rainfall Area," by W. E. Isaac (communicated by R. S. Adamson).

3. "The Reproduction, Embryology, and Metamorphosis of the Cape Crawfish, *Jasus lalandii*," by C. von Bonde.

4. "Veld-burning Experiments at Oakdale, Riversdale," by M. R. Levyns.

5. "Notes on a Second Intermediary Host for Trematodes," by F. G. Cawston.

6. "On the Flora of a High Mountain in South-West Africa," by J. V. L. Rennie.

7. "Some Prehistoric Skeletal Remains from the Natal Coast," by A. Galloway.

8. "The 'Galjoen' Fishes of South Africa," by J. L. B. Smith.

9. "Some Biological Notes on *Boscia rehmanniana*, Pest., and *Olea verrucosa*, Link," by E. E. Galpin and E. A. Galpin.

10. "The Organic Matter Content and Carbon-Nitrogen Ratios of Some Semi-Arid Soils of the Cape Province," by W. E. Isaac and B. Gershill (communicated by R. S. Adamson).

11. "The Alkaloids of *Strychnos Henningsii* (3rd Communication). Isolation of a Second Crystalline Alkaloid," by M. Rindl and M. L. Sapiro.

12. "The Genus *Tripterodon*, Playfair," by J. L. B. Smith.

13. "*Taraxacum magellanicum* Comm. in South Africa," by J. Burtt Davy.

14. "The Nature of Temperament," by S. Biesheuvel (communicated by H. A. Reyburn).

15. "Notes on the Stem Structure of *Boscia rehmanniana*, Pest.," by R. S. Adamson.

16. "Recent Changes in Terminology in European Prehistory," by A. J. H. Goodwin.

17. "Observations on certain Wood-boring Coleoptera occurring in South Africa," by J. A. Pringle (communicated by J. F. V. Phillips).

18. "The Smithfield 'N' Culture," by C. van Riet Lowe.

19. "Studies in Deciduous Fruit. III. The Chemical Changes in Kelsey and Gaviota Plums during Growth," by I. Donen.

20. "Studies on Dropping-Berry in Waltham Cross Grapes (*Vitis vinifera*)," by D. G. Haylett.

21. "Some Interesting New Fishes from South Africa," by J. L. B. Smith.

22. "Variation in the Phytoplankton of Table Bay. October 1934–October 1935, with a Note on the Chemical Analysis of *Chaetoceras*," by W. J. Copenhagen.

23. "The Relation between Thunderstorms and Atmospherics in South Africa," by D. B. Hodges and B. F. J. Schonland.

24. "Recent Progress in the Study of the Lightning Discharge," by B. F. J. Schonland, D. J. Malan, and H. Collens.

25. "Intensity Variations in the Main Return Lightning Stroke," by D. J. Malan.

26. "Several new Gobioid and Fresh-water Fishes from South Africa," by J. L. B. Smith.

27. "Studies in South African Ricciaceae.—I. Three Annual Species: *R. crystallina*, L., *R. cupulifera* sp. nov., and *R. curtisii*, T. P. James," by A. V. Duthie and S. Garside.

At the Ordinary Meeting of the Society, on August 21, Prof. A. Brown held an exhibition on "Seismographic Records of the Quetta Earthquake, as received at Cape Town."

Presidential Address, "The Superficial Deposits of the Kalahari."

Vol. XXIII, parts 1 to 3, of the Society's Transactions have been issued during the year.

GEORGE ARNOLD, REGINALD FREDERICK LAWRENCE, and CECIL VAN BONDE were elected Fellows of the Society in 1934.

At the end of 1935 the number of Honorary Fellows was 1, Fellows 77, Members 127. During the year one Fellow and three Members resigned, and the names of one Fellow and three Members were struck off the list. Fourteen new Members were elected during the year.

The death of Monsignor KOLBE, who resigned from the Society at the end of 1935 after thirty-nine years' membership of it and the South African Philosophical Society, on January 12, 1936, is recorded with regret.

The Society records with regret the death of Dr. MARIUS WILSON. Dr. WILSON had been a Member of the Society since 1903, and a Fellow since 1909.

The thanks of the Council are due to the Minister for Education and the Government for the grant of £400 for the year 1935–6; the Council's thanks are due, too, to the Research Grant Board for a Government grant of £12 towards printing a paper by Mrs. LEVYNS, and Carnegie grants of £35 towards printing one by Miss F. RICH, and £30 towards printing one by J. L. B. SMITH.

The following gifts were received by the Library during the year:—

From the Government, British Somaliland, The Mesozoic Palaeontology of British Somaliland, January 1935; from the Abbé Breuil, Les Peintures Rupestres Schématiques de la Péninsule Ibérique, part 4, by the DONOR; from J. W. Pont, Physiological Studies with Seeds of Andropogon Sorghum, Brot, by the DONOR; from the Carnegie Corporation (Research Grant Board, Union of South Africa) and the author, Moths of South Africa, Vol. II, by A. J. T. JANSE; from the Citrus Experimental Station, Mazoe, S. Rhodesia, Annual Report for 1933; from the International Council of Scientific Unions, Report of Proceedings of 2nd General Assembly, Brussels, July, 1934; from W. J. Hall, Observations on the Coccidae of S. Rhodesia, VI, by the DONOR; from the publishers, Dresden, Photographie und Forschung, for 1935; from the Swedish Phytogeographical Society, Uppsala, Das Ozeanische Element der Strauch- und Laubflechtenflora von Skandinavien, by GUNAR DEGELIUS; from C. M. Schwellnuss, The Nickel-Copper Occurrence in the Bushveld Igneous Complex west of the Pilandsbergen," by the DONOR; from M. H. H. Walters, Globular Clusters, by the DONOR; from the Egyptian University, Cairo, Bulletin of the Faculty of Science, Nos. 1–5, 1934–5; from the McGregor Museum, Kimberley, Bantu Tribes of S. Africa. . . . Photographic Studies by A. M. DUGGAN-CRONIN, Vol. IV, Section I, 1935; from the Meijikai, Tokyo, What is Nippon Kokutai? by CHIGAKU TANAKA.

During the past year the number of cards returned to the Regional Bureau for South Africa of the International Catalogue of Scientific Literature was 926.

The following exchanges have been discontinued:—Montana University; Adelaide Observatory; R. Accademia delle Scienze di Torino, Turin.

New exchanges have been arranged with the following institutions:—Sociedad Venezolana de Ciencias Naturales, Caracas; Deutsche Kolonial- und Uebersee-Museum, Bremen; Meteorologisches Institit der Universität, Berlin; Royal Society of Tasmania, Hobart.

The American Academy of Arts and Sciences, Boston, is now sending Memoirs in addition to Transactions.

A list of the Serial Publications in the Society's Library was published and circulated during the year. Largely as a direct consequence of this step numerous back numbers have since been obtained, as gifts or by exchange. They are listed on a separate sheet, ready for insertion into the Library Catalogue.

378 volumes of the Society's Library were bound in 1935.

The Librarian reports a still further increase in the use of the Library by students and members. A more exact record is now being kept.

During the year the Council has revised the Statutes of the Society. Copies will be circulated as soon as possible and will be sent to new members. These Statutes will come into effect with the commencement of the 1936 Session.

A. J. H. Goodwin,
Hon. General Secretary.

REVENUE AND EXPENDITURE ACCOUNT FOR THE YEAR, JANUARY 1, 1935, to JANUARY 9, 1936.

Revenue.

	£ s. d.	£ s. d.
To Subscriptions collected for 1935:—		
Subscriptions collected for 1932	2 0 0	
,, ,, 1933	10 0 0	
,, ,, 1934	28 14 4	
,, ,, 1935	263 17 1	
,, ,, in advance for 1935	3 2 0	
,, ,, in advance for 1936	2 4 0	
,, ,, in advance for 1937	1 0	
Life Subscriptions paid from 1935	15 0 0	
Life Subscriptions, wholly or in part, in advance from 1936	8 0 0	
Outstanding Subscriptions at January 9, 1936	42 0 0	
	374 18 5	
Less: Outstanding Subscriptions at December 31, 1934, £64, 14s. 4d.; Subscriptions paid in advance, £10, 5s. ..	74 19 4	
		299 19 1
,, Entrance Fees		14 0 0
,, Government Grant		400 0 0
,, Interest received:—		
On money in Savings Bank Department of Standard Bank	1 14 3	
On money in Cape of Good Hope Savings Bank	11 7 8	
On money in Post Office Savings Bank	1 15 0	
		14 16 11
,, Sale of Publications in 1935	38 13 2	
Plus: Amount due for Sales in 1935 ..	4 19 10	
Amount paid to Neill & Co. for sales and held by them ..	3 12 9	
	47 5 9	
Less: 1934 Accounts paid in 1935 .. .. .. £4 7 5		
1933 Account struck off as irrecoverable 1 0 11		
	5 8 4	
		41 17 5
		£770 13 5

Expenditure.

	£ s. d.	£ s. d.	£ s. d.
By Publications:—			
Corrected Balance of 1934 Account, Neill & Co. ..	2 2 9		
Corrected Account, Neill & Co., for Vol. XXII., Part 4 ..	148 11 0		
Account, Neill & Co., for:—			
Vol. XXIII., Part 1 ..	117 16 10		
Vol. XXIII., Part 2 ..	114 3 3		
Vol. XXIII., Part 3 ..	127 7 9		
Postages	2 3		
Costs of Drafts to Neill & Co.	4 9 3		
		514 13 1	
Less: Uncorrected Account, Neill & Co., for Vol. XXII., Part 4 (issued December, 1934)	161 15 3		
Uncorrected Balance of 1934 Account, Neill & Co.	1 13 3		
Grants towards publications through Research Grant Board	77 0 0		
Receipts for Sale of Extra Reprints in 1935	9 4 6		
Amount due for sales and cost of alteration in proofs for 1935	9 5 5		
	258 18 5		
Less: Receipts for Sales in 1931 and 1934	2 0 9		
		256 17 8	
			257 15 5
,, Compilation of International Catalogue of Scientific Literature			16 16 0
,, Clerical Assistance and Work in Library			84 0 0
,, Local Printing and Stationery			42 1 6
,, Postages and Petties			21 15 6
,, Bank Charges for Commissions, Ledger Fees, etc.		£3 19 10	
Less: Commissions paid by Members ..		1 18 5	
			2 1 5
,, Hire of Rooms and Caretaker			6 6 0
,, Insurance of Library and Insurance of back numbers with Neill & Co.			2 0 0
,, Binding			111 1 0
,, Purchases			1 12 4
,, Catalogue of Serials, printing and envelopes for sending			48 8 9
,, Profit in year 1935			176 15 6
			£770 13 5

ASSETS AND LIABILITIES AT JANUARY 9, 1936.

Assets.*

	£	s.	d.
Money in Savings Bank Department of Standard Bank	20	17	11
Money in Cape of Good Hope Savings Bank	325	9	3
Money in Post Office Savings Bank	151	15	0
Cash Balance, Current Account, at Standard Bank	51	9	1
Arrears of Subscriptions as in Statement for 1934, £64, 14s. 4d.; less £40, 14s. 4d. paid in 1935 and £16 struck off as irrecoverable	8	0	0
Arrears of Subscriptions for 1935, £40; less £6 struck off as irrecoverable	34	0	0
Amount due for Sale of Publications in 1933, £1, 0s. 11d.; less £1, 0s. 11d. struck off as irrecoverable	—		
Amount due for Sale of Publications in—			
1934	1	2	7
1935	4	19	10
1935, held by Neill & Co.	3	12	9
Amount due for Sale of Extra Reprints in 1935	9	5	5
	£610	11	10

Liabilities.

	£	s.	d.	£	s.	d.
Subscriptions received in advance for 1936 and 1937				10	5	0
Amount for Sale of Publications received in advance for 1934 (Stechert & Co.)					15	4
Amount for Sale of Publications received in advance in 1931 (Max Weg)					18	9
Excess of Assets over Liabilities:—						
Amount at December 31, 1934	421	17	3			
Add: Profit in 1935	176	15	6			
				598	12	9
				£610	11	10

* Exclusive of value of Library and Publications of the Society held in stock.

LAWRENCE CRAWFORD,
Hon. Treasurer.

We hereby certify that we have examined the above Accounts of Revenue and Expenditure, and of Assets and Liabilities, with the books, vouchers, and other documents relating thereto, and that in our opinion these Accounts set forth a correct statement of the affairs of the Society.

J. W. C. GUNN.
B. J. RYRIE.

NOTE.—The Council wishes to point out that the profit of about £177 in the year is due to the unexpected delay in publishing Vol. XXIII., Part 4, of the Society's Transactions; it was hoped that that Part would be issued in 1935 and that its cost, about £150, would be an item in the expenditure for the year.